BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA

Red-spotted Purple (*Limenitis arthemis astyanax*)

This species comprises one of more than 80 new county records for butterflies documented from Fort Pickett, Virginia, as discussed on pages 38-41 of this issue.

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Cover: Red-spotted Purple (*Limenitis arthemis astyanax*) at Fort Pickett, Virginia; photograph by Steven M. Roble.
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The Flora of Manassas National Battlefield Park, Prince William and Fairfax Counties, Virginia

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ABSTRACT

Manassas National Battlefield Park (MNBP) is a 1,179 ha National Park Service Unit located 42 km west of Washington, DC. A total of 706 plant species and subspecific taxa are reported from the park for the 1993-2000 period. These include 53 new Prince William County, Virginia, records and six state-rare taxa. Ten habitat types are described for MNBP, and the habitats where each taxon was observed are listed.

Key words: flora, Manassas National Battlefield Park, Prince William County.

INTRODUCTION

Manassas National Battlefield Park (MNBP) is a National Historical Park of 1,779 ha located on the site of two important Civil War conflicts. It has a long history of agricultural use that is reflected in the current vegetation cover. Presently, 839 ha are covered by forests that vary in character from early successional *Pinus virginiana* (Virginia pine) stands to relatively mature oak-hickory and bottomland hardwood forests. The remaining 940 ha, excluding roadways and buildings, are occupied by fields and disturbed areas covered by herbaceous and shrubland vegetation.

This flora is a product of work done by the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) at MNBP from 1993 to 2000. In 1993, the National Park Service (NPS) contracted DCR-DNH to conduct a rare species survey of two recently acquired properties (Stuarts Hill and Brawner Farm) at the western end of the Park (Fleming, 1993). In 1997, DCR-DNH conducted a similar inventory for rare species and significant natural communities within MNBP lands along a 0.4 km corridor adjacent to Bull Run and at all habitats underlain by diabase and metasiltstone within the Park (Belden et al., 1998). In 2000, the NPS contracted DCR-DNH to produce a vascular plant species list for the entire Park (Belden & Fleming, 2001). Concurrently, DCR-DNH ecologist Gary Fleming collected plot data from various vegetation types in the Park as part of an ongoing effort to classify natural communities throughout Virginia. During the period 2001-2003, DCR-DNH was contracted to map the Park's forested ecological communities (Fleming & Weber, 2003). These projects afforded the authors the opportunity to collect and/or record taxa observed within MNBP over an extended period.

STUDY AREA

MNBP is located in the Piedmont physiographic province (Fennemann, 1938), approximately 4 km northwest of Manassas City, Virginia, and 42 km west of Washington, DC. Most of the Park is in eastern Prince William County, Virginia, with a very small portion extending into Fairfax County. The study area is situated in the Culpeper Basin, a large Mesozoic trough that stretches across the central Piedmont from Culpeper County north through Fauquier, Prince William, and Loudoun counties into Maryland (Lee, 1979). The Culpeper Basin is a distinctive regional landscape with relatively low relief and gently rolling to nearly level topography. The study area is very representative of the region, with broad, low ridges, extensive upland "flats," and shallow, sluggish drainageways.

Streams within MNBP are part of the Occoquan River watershed. Bull Run, one of the largest secondary streams of the region, borders much of the eastern edge of the Park. The watershed of Youngs Branch, a major Bull Run tributary, drains most of the study area. Well-developed floodplain landforms, including depositional bars, levees, and backswamps, occur only along Bull Run. Floodplains along Youngs Branch and several of its larger tributaries are much smaller and lack the microtopographic diversity of large-stream and river floodplains. Headwater drainages throughout the study area are characterized by very small, sometimes braided channels with little alluvial deposition, and are flanked by flats with ephemeral or seasonal flooding controlled by fluctuating groundwater. Similar but isolated, groundwater-influenced depressions are also scattered through the Park.

MNBP is underlain by sedimentary, meta-sedimentary, and igneous rocks of Triassic and Jurassic age. Siltstone of the Ball's Bluff Formation is the most extensive bedrock type in the area. This material is a red to purplish-brown, iron-rich, micaceous siltstone with thin to medium bedding that tends to produce platy to slab-like fragments when weathered. Calcium is abundant in concretions, veins, and cement. Minor interbeds of red silty shale and arkosic sandstone are also present. This formation constitutes the parent material of almost all soils in the eastern half of the study area (Lee, 1977; Leavy et al., 1983).

The western half of the Park contains substantial areas underlain by intrusive diabase, which occurs in irregular dikes, stocks, and sills. This diabase is a dense, medium-grained, dark-gray to black, mafic igneous rock composed primarily of feldspar and pyroxene (Lee, 1979). This bedrock is well expressed in a narrow dike that originates near Wellington to the south of MNBP and extends northward through the Park, passing west of Groveton and ending just southeast of Sudley. Other diabase intrusions are located in the vicinity of Stuarts Hill, south of Battery Heights, and on the ridge east of Brawner Farm (Leavy et al., 1983). Elder (1989) indicates that soils derived from diabase are also located in the vicinity of Bald Hill. Thick, residual soils cover most diabase intrusions but often contain spheroidally weathered boulders at the surface.

Thermally metamorphosed sedimentary rocks surround the diabase intrusive bodies (Lee, 1979). Bands of these rocks are generally less than 0.5 km wide within the Park and often much narrower. They are composed of red-brown siltstone and shale hornfels that have been altered under intense heat and pressure. Metamorphic minerals such as epidote, cordierite, pyroxene, and garnet are common along joints or fractures (Leavy et al., 1983).

The two major geologic units of MNBP (siltstone and diabase) greatly influence soil development, texture, and chemistry. In general, soils weathered from diabase are loamy, rich in clay minerals, and tend to have well developed subsoil hardpans that limit permeability. They also have significantly higher pH, calcium, magnesium, and manganese concentrations, along with significantly lower iron concentrations, than soils weathered from siltstone. Although a few of the latter have moderately clayey subsoils, most have silty upper horizons and loamy subsoils with good drainage. Most (but not all) residual upland soils weathered from siltstone are strongly to extremely acidic, with relatively low base cation concentrations (except of iron). However, below the limit of surface leaching, calcareous soil material may be abundant and is frequently exposed on steep slopes and bluffs undercut by streams.

Elder (1989) indicates that approximately 79% of the soils in the Park are derived from siltstone or metasiltstone, with the remainder weathered from diabase (19%) or alluvium (2%). The most common soil types in the study area, covering more than 40% of the Park, belong to the Arcola and Nestoria series. Often occurring in mosaics that are too difficult to map as individual units, these soils are moderately deep to shallow, well-drained silt loams with gravelly silt loam subsoils.

The natural vegetation of the study area was broadly described by Braun (1950) as belonging to the Piedmont Section of the Oak-Chestnut Forest Region. Centered in the Appalachian Mountains, this vegetation unit was formerly characterized by various mixtures of *Quercus* spp. (oaks) and *Castanea dentata* (American chestnut), with small inclusions of *Pinus* spp. (pines) on xeric ridges and mixed mesophytic forest in coves, ravines, and stream bottoms. Following the removal of American chestnut as an overstory tree by an introduced fungal blight (*Cryphonectria parasitica*) during the early decades of the 20th century, this region is now broadly characterized as mixed oak forest (Stephenson et al., 1993) or oak-hickory-pine forest (Küchler, 1985).

It is worth noting that because of its low relief and distinctive soils, the original vegetation of the Culpeper Basin was probably dissimilar to most other parts of the Oak-Chestnut Forest Region. There is little evidence that chestnut was important in the Basin, and the general vegetation of the area may have been closer to Braun's (1950) more western Oak-Hickory Forest Region. In addition, the relatively flat, poorly drained soils of the Basin have always supported unique communities with an abundance of *Quercus palustris*

(pin oak), *Quercus bicolor* (swamp white oak), and other species that are decidedly less common in other physiographic subregions of the Piedmont. Braun (1950), in fact, notes that moist flats on the "Piedmont Lowland" of Virginia are "quite different, with pin oak, red maple, willow oak, swamp white oak, and sweet gum."

Many of the rare plant species found at MNBP have affinities with prairie vegetation west of the Appalachians. Accounts of early explorers and settlers indicate that the Culpeper Basin originally had extensive natural savannas and grasslands, which might explain the presence of these disjunct or peripheral species (Allard & Leonard, 1962; Brown, 2000). These prairie-like habitats probably remained open over the long term because of frequent fires, both natural and deliberately set by Native Americans, that traveled unobstructed across the gentle terrain of the Basin (Maxwell, 1910; Van Lear & Waldrop, 1989). Plastic hardpan soils, weathered from diabase and locally known as "Jackland" because of the abundance of *Quercus marilandica* (blackjack oak) on them, were probably the most favorable for development of these grassland openings.

The study area and most other parts of the Culpeper Basin have been settled for almost three centuries. In the post-settlement era, the original grasslands were destroyed by extensive clearing and agriculture, widespread fire suppression, and repeated cutting, which has resulted in dense secondary forests. Old fields undergoing secondary succession in this area are generally characterized by stands of *Pinus virginiana* (Virginia Pine), *Juniperus virginiana* (eastern red cedar), *Cornus florida* (flowering dogwood), and fast-growing hardwoods such as *Fraxinus americana* (white ash) and *Liriodendron tulipifera* (tulip-poplar).

The mosaic of agricultural fields and secondary forests at MNBP has shifted considerably since the Civil War. A number of sites that were cleared at the time of the Civil War battles are now reforested, and other historically forested sites have since been cleared (National Park Service, unpublished data). Other areas, including parts of Stuarts Hill, Bald Hill, the ridges east of Brawner Farm and south of Battery Heights, and the ridge north of Groveton, have been continuously forested (although cut) since the time of the Civil War.

In recent years, large portions of the Culpeper Basin in Fairfax, Loudoun, Prince William, and Fauquier counties have been subjected to intense development pressure as growth of the Washington, DC, area has expanded westward. As a result, many of the region's finest natural areas have been destroyed or threatened. Increasingly, MNBP is becoming a natural area oasis as development spreads from nearby Manassas.

METHODS

This flora was developed through informal plant collecting at MNBP in 1993 and 1997 and from systematic collecting and observations during the 2000 field season. In 1993 and 1997, plants were collected on an informal basis in conjunction with rare species surveys at the Park. The focus of these collections was on rare and unusual taxa and on taxa not previously documented for Prince William County as determined by Harvill et al. (1992).

In 2000, DCR-DNH was contracted to develop a flora for the Park. To initiate this project, field notes and specimen records were reviewed from DCR-DNH fieldwork at MNBP prior to 2000. From these records, a preliminary species list was developed. Fieldwork for this project was conducted by the authors between 17 April and 7 September 2000. Monthly visits were made to MNBP to ensure that species visible at different times during the growing season would be recorded. Areas visited were chosen to represent a wide variety of habitat types and geographic locations.

The flora was inventoried using two methods: (1) walking across environmental gradients and thoroughly exploring discrete, productive habitats; and (2) intensive sampling of 28 vegetation plots. In addition to aiding in the characterization of habitats, plot sampling requires a full inventory of flora within the plot area and therefore often captures taxa that may be overlooked during walking surveys. Plots were sampled using the relevé method (Peet et al., 1998), with 400 m^2 plots established in forest vegetation and 100 m^2 plots in grasslands. Within each plot, all vascular plants were recorded, and the total cover of each taxon was estimated as a vertical projection onto the plot area. In addition, the cover of woody species was estimated in six vertical height strata, and the diameters of all woody stems $\geq$2.5 cm in diameter at breast height were measured. A standard set of environmental data, including slope, slope shape, aspect, surface substrate cover, topographic position, drainage class, and soil moisture regime, were measured or estimated. In addition, a small soil sample was collected from the A horizon of each plot and analyzed for pH, phosphorus, exchangeable cations, and extractable micronutrients by Brookside Laboratories, New Knoxville, Ohio. A preliminary cluster analysis of the compositional data provided a basis for identifying the principal habitat types used in this study.

Species that could not be readily identified in the field were collected and identified later using standard floras for the area, including Fernald (1950), Radford et al. (1968), and Gleason & Cronquist (1991). A draft flora in progress (Weakley, 2000) was consulted for

more recent treatments. Plant specimens that represented new county records and other noteworthy specimens were pressed, labeled and deposited in the DCR-DNH plant reference collection or at one of the following herbaria: Virginia Polytechnic Institute and State University (VPI), George Mason University (GMUF), and The College of William and Mary (WILLI). T. F. Wieboldt (VPI) assisted in identifying several specimens.

Habitat data were collected in the field and compiled for each taxon collected or observed. Ten habitat types were designated for MNBP and the habitats where each taxon was observed were recorded. Habitat types are defined as follows:

1. Upland Acidic Forest. This habitat type includes relatively mature forests on very strongly to extremely acidic, infertile soils weathered from siltstone. It covers about 6% of the Park, mostly on low ridges and rolling to flat uplands. The dry forest vegetation is typically dominated by *Quercus alba* (white oak), with other *Quercus* spp. (oaks) and *Carya* spp. (hickories) as frequent overstory associates. *Acer rubrum* (red maple), *Nyssa sylvatica* (black gum), *Cornus florida* (flowering dogwood), and *Sassafras albidum* (sassafras) are common understory species, while the low ericaceous shrubs *Vaccinium pallidum* (early lowbush blueberry), *V. stamineum* (deerberry), and *Gaylussacia baccata* (black huckleberry) are patch-dominants of the shrub layer. A small area of the habitat type is dominated by a mixed forest of *Quercus* spp., *Pinus strobus* (eastern white pine), *Tsuga canadensis* (eastern hemlock), and ericaceous shrubs. Herbaceous diversity is relatively low in this habitat.

2. Upland Basic Forest. This habitat type includes relatively mature forests on more fertile soils weathered from diabase or calcareous phases of siltstone. It covers about 13% of the Park on low ridges, rolling or flat uplands, and steep bluffs along Bull Run. Vegetation is primarily a dry-mesic oak-hickory forest dominated by *Quercus alba*, *Q. rubra* (red oak), *Carya glabra* (pignut hickory), *C. ovalis* (red hickory), and *Fraxinus americana* (white ash). *Carya alba* (mockernut hickory), *Juglans nigra* (black walnut), and *Quercus velutina* (black oak) are frequent overstory associates. Dominant or characteristic understory species include *Cercis canadensis* (eastern redbud), *Ulmus rubra* (slippery elm), *Chionanthus virginicus* (fringetree), *Ostrya virginiana* (eastern hop-hornbeam), and *Juniperus virginiana* (eastern redcedar). The herb layer is open but very diverse and characterized by patch-dominance of the forest grasses *Dichanthelium boscii* (Bosc's panic grass), *Elymus hystrix* var. *hystrix* (bottlebrush grass), and *Muhlenbergia sobolifera* (cliff muhly). A small area of this habitat type occupies a steep, east-facing bluff along Bull Run and contains more mesophytic vegetation dominated by *Carya cordiformis* (bitternut hickory), *Quercus muehlenbergii* (chinkapin oak), *Fraxinus americana*, *Asimina triloba* (pawpaw), and *Staphylea trifolia* (bladdernut).

3. Swamp Forest. This unit covers < 1% of the Park and is restricted to seasonally flooded backswamps along Bull Run. Vegetation is a hydrophytic forest dominated by *Quercus palustris* (pin oak), *Quercus bicolor* (swamp white oak), and *Fraxinus pennsylvanica* (green ash). The habitat has a pronounced hummock-and-hollow microtopography, with water-tolerant herbs such as *Saururus cernuus* (lizard's tail) and *Boehmeria cylindrica* (false nettle) dominant in the seasonally flooded sloughs and hollows. A large variety of *Carex* spp. (sedges) occupies the slightly better drained hummocks.

4. Alluvial Forest. Forested alluvial floodplains cover about 5% of the Park, primarily along Bull Run, Youngs Branch, and a few of their largest tributaries. These forests are well developed on the high, fertile, sandy levees along Bull Run. *Acer negundo* (boxelder), *Platanus occidentalis* (sycamore), *Carya cordiformis*, *Celtis occidentalis* (sugarberry), and *Ulmus americana* (American elm) are typical trees of stands that have not been disturbed recently. The understory is dominated by *Asimina triloba* and *Lindera benzoin* (spicebush). The herb layer is lush with nutrient-demanding species such as *Mertensia virginica* (Virginia bluebells), *Asarum canadense* (wild ginger), *Floerkea proserpinacoides* (false mermaid-weed), and *Laportea canadensis* (wood nettle). Along Youngs Branch and other smaller streams, floodplains are smaller and more disturbed, supporting less diverse vegetation.

5. Upland Depression Swamp. This habitat type occupies <1% of the Park in isolated upland depressions and elongate areas along sluggish headwater drainages. Sites are shallowly flooded by perched groundwater during winter and spring months. Woody vegetation is similar to that of the Swamp Forest habitat type, with *Quercus palustris* and *Q. bicolor* prevalent. The lower woody layers are dominated by *Viburnum prunifolium* (smooth black-haw) and climbing or scrambling vines of *Toxicodendron radicans* (poison ivy), *Parthenocissus quinquefolia* (Virginia creeper), and *Smilax rotundifolia* (common greenbrier). The herbaceous flora is typically rather sparse and characterized by species tolerant of seasonal inundation and extended draw-down periods

during which soils may become quite dry.

6. Successional Scrub and Forest. Extensive areas of the Park are covered with early-successional forests. The most common of these, covering more than 19% of the Park, is a vegetation type dominated by *Pinus virginiana* (Virginia pine) and/or *Juniperus virginiana* that colonized fields abandoned during the past 70 years. Additional areas of this habitat type support young, weedy, basic forests dominated by *Fraxinus americana* and *Pinus virginiana*. A number of floodplains were once cleared and now support nearly monospecific stands of *Acer negundo* or *Platanus occidentalis*. The herbaceous flora of early-successional scrub and forest habitats varies widely with site conditions and land-use history, but generally contains large populations of invasive exotic weeds.

7. Upland Grassland. Periodically mowed fields occupy substantial areas of the Park. An irregular, long-term mowing regime has resulted in herbaceous vegetation dominated by the warm-season perennial grasses *Sorghastrum nutans* (Indian grass) and *Schizachyrium scoparium* (little bluestem). Characteristic forb associates in these prairie-like habitats include *Pycnanthemum tenuifolium* (narrow-leaved mountain-mint), *Solidago juncea* (early goldenrod), *S. nemoralis* (gray goldenrod), *Liatris squarrosa* (scaly blazing-star), *Lespedeza capitata* (round-head bushclover), *L. virginica* (slender bushclover), and *Desmodium* spp. (tick-trefoils).

8. Open Wetlands. This category includes an eclectic group of small-patch habitats, including several "marshes" resulting from drainages impounded by roads, artificial ponds and pond shores, stream-bottom swales in fields and powerlines, and irregularly exposed bars and shores along Bull Run. Although very limited in extent, these habitats contain a number of hydrophytic species that were not recorded elsewhere in the Park.

9. Open Ruderal Habitats. This unit includes weedy fields dominated by cool-season grasses, roadsides, lawns, parking lot cracks, and recently bulldozed areas. Vegetation of these areas is generally dominated by exotics and weedy natives.

10. Rock Outcrops. Outcrops are represented in the study area by siltstone cliffs and ledges along Bull Run and by a few small, metasiltstone "flatrocks" in fields. Siltstone outcrops are generally shaded and calcareous, with crevices and ledges supporting base-loving lithophytes such as *Hydrangea arborescens* (wild hydrangea), *Asplenium trichomanes* (maidenhair spleenwort), *Asplenium rhizophyllum* (walking fern), *Aquilegia canadensis* (wild columbine), and *Arabis lyrata* (lyre-leaf rockcress). Flatrocks generally support a sparse vegetation of xerophytic annuals such as *Diodia teres* (buttonweed), *Krigia virginica* (dwarf dandelion), and *Isanthus brachiatus* (false pennyroyal).

RESULTS

A total of 706 plant species and subspecific taxa was recorded for MNBP. These are listed in Table 1 and include 16 pteridophytes, 4 gymnosperms, 501 dicot angiosperms, and 185 monocot angiosperms. The taxa are contained within 111 plant families and 362 genera. Three families, the Asteraceae (90 taxa), the Poaceae (81 taxa), and the Cyperaceae (60 taxa) comprise 32.7 percent of the flora. *Carex* is by far the largest genus with 47 taxa. The 128 non-native taxa represent 18.1 percent of the flora. Fifty-three new Prince William County records were collected.

Six taxa documented for MNBP are considered rare in Virginia by DCR-DNH (Townsend, 2002). These are *Asclepias purpurascens* (purple milkweed), *Buchnera americana* (blue-hearts), *Isoetes appalachiana* (Appalachian quillwort), *Penstemon hirsutus* (hairy beardtongue), *Stachys pilosa* var. *arenicola* (marsh hedgenettle), and *Trifolium reflexum* (buffalo clover). None of these taxa is considered rare on a global basis. In addition, seven taxa considered by DCR-DNH to be uncommon in Virginia were recorded: *Carex bushii* (Bush's sedge), *Carex meadii* (Mead's sedge), *Erigenia bulbosa* (harbinger-of-spring), *Floerkea proserpinacoides* (false mermaid-weed), *Iris versicolor* (blueflag), *Juglans cinerea* (butternut), and *Zanthoxylum americanum* (northern prickly-ash).

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Table l. Flora of Manassas National Battlefield Park. The list is arranged by major plant groups: Pteridophyta (ferns and fern allies), Gymnospermae (non-flowering seed plants), and Angiospermae (flowering plants). The Angiospermae are further divided into the Dicotyledoneae and the Monocotyledoneae. Within each major group, families, genera, species, and subtaxa are arranged alphabetically. Scientific nomenclature follows Kartesz (1999) with the exception of *Setaria pumila* (Poir.) Roemer & J.A. Schultes ssp. *pumila*, where it appears that the Kartesz name, *Pennisetum glaucum* (L.) R. Br., is in error (A. Weakley, pers. comm.). Synonyms, shown following an equal sign (=), are provided for some taxa where Kartesz (1999) departs sharply from other familiar sources. Non-native taxa, as determined from a consensus of the standard regional floras, are preceded by an asterisk (*). Common names follow Kartesz (1999) or other standard floras. The habitat(s) where each taxon was observed are shown in a coded format as follows: 1 = Upland Acidic Forest, 2 = Upland Basic Forest, 3 = Swamp Forest, 4 = Alluvial Forest, 5 = Upland Depression Swamp, 6 = Successional Scrub and Forest, 7 = Upland Grassland, 8 = Open Wetlands, 9 = Open Ruderal Habitats, 10 = Rock Outcrops. The last column indicates those species for which a voucher specimen was collected (V) and which of those vouchers were Prince William County records (C).

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
PTERIDOPHYTA			
ASPENIACEAE			
Asplenium platyneuron (L.) B.S.P.	ebony spleenwort	1,2,5,6,10	
Asplenium rhizophyllum L.	walking fern	10	
Asplenium trichomanes L.	maidenhair spleenwort	10	
DENNSTAEDTIACEAE			
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller	bracken fern	1	
DRYOPTERIDACEAE			
Cystopteris protrusa (Weatherby) Blasdell	lowland brittle fern	2,4	
Dryopteris intermedia (Muhl. ex Willd.) Gray	evergreen wood-fern	1	
Dryopteris marginalis (L.) Gray	marginal wood-fern	2,10	
Onoclea sensibilis L.	sensitive fern	3,4,5,6,8	
Polystichum acrostichoides (Michx.) Schott	Christmas fern	1,2	
ISOETACEAE			
Isoetes appalachiana D.F. Brunton & D.M. Britton = *Isoetes engelmannii* A. Braun var. *georgiana* Engelm.	Appalachian quillwort	5	V,C
LYCOPODIACEAE			
Lycopodium digitatum Dill. ex A. Braun	common running pine	6	
OPHIOGLOSSACEAE			
Botrychium dissectum Spreng.	cutleaf grape-fern	6	
Botrychium virginianum (L.) Sw.	rattlesnake fern	2	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
POLYPODIACEAE			
Polypodium virginianum L.	rock polypody	10	
PTERIDIACEAE			
Adiantum pedatum L.	northern maidenhair fern	1	
THELYPTERIDACEAE			
Thelypteris noveboracensis (L.) Nieuwl.	New York fern	6	
GYMNOSPERMAE			
CUPRESSACEAE			
Juniperus virginiana L.	eastern redcedar	1,2,3,5,6,7	
PINACEAE			
Pinus strobus L.	eastern white pine	1	V
Pinus virginiana P. Mill.	Virginia pine	1,2,6	
Tsuga canadensis (L.) Carr.	eastern hemlock	1	
ANGIOSPERMAE: DICOTYLEDONEAE			
ACANTHACEAE			
Justicia americana (L.) Vahl	common water-willow	4,8	
Ruellia caroliniensis (J.F. Gmel.) Steud.	Carolina wild-petunia	7	
ACERACEAE			
Acer negundo L.	boxelder	2,3,4,5	
**Acer platanoides* L.	Norway maple	5	V,C
Acer rubrum L.	red maple	1,2,3,5,6	
Acer saccharinum L.	silver maple	9	
ANACARDIACEAE			
Rhus aromatica Ait.	fragrant sumac	1,2	
Rhus copallinum L.	winged sumac	7	
Rhus glabra L.	smooth sumac	7	
Rhus typhina L.	staghorn sumac	7	
Toxicodendron radicans (L.) Kuntze	poison ivy	1,2,3,4,5,6,8,10	
ANNONACEAE			
Asimina triloba (L.) Dunal	pawpaw	1,2,3,4,6	
APIACEAE			
Angelica venenosa (Greenway) Fern.	hairy angelica	9	
Chaerophyllum procumbens (L.) Crantz	spreading chervil	4	
Cicuta maculata L.	water-hemlock	3	
Cryptotaenia canadensis (L.) DC.	honewort	3,4	
**Daucus carota* L.	Queen Anne's lace	7,9	
Erigenia bulbosa (Michx.) Nutt.	harbinger-of-spring	4	V,C
Osmorhiza longistylis (Torr.) DC.	aniseroot	4	
Sanicula canadensis L.	black snakeroot	2,3,4,5,6	
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe = *Sanicula gregaria* Bickn.	clustered snakeroot	5	V,C
Taenidia integerrima (L.) Drude	yellow pimpernel	1,2	V
Thaspium barbinode (Michx.) Nutt.	hairy-jointed meadow-parsnip	2	
Zizia aptera (Gray) Fern.	heartleaf golden alexanders	1	
Zizia aurea (L.) W.D.J. Koch	golden alexanders	2	
APOCYNACEAE			
Apocynum androsaemifolium L.	spreading dogbane	9	
Apocynum cannabinum L.	Indian hemp	7,9	
**Vinca major* L.	greater periwinkle	9	
**Vinca minor* L.	periwinkle	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
AQUIFOLIACEAE			
Ilex opaca Ait.	American holly	6,7	
Ilex verticillata (L.) Gray	winterberry	3	
ARISTOLOCHIACEAE			
Aristolochia serpentaria L.	Virginia snakeroot	2	
Asarum canadense L.	wild ginger	2,4	
ASCLEPIADACEAE			
Asclepias incarnata L.	swamp milkweed	7,8	
Asclepias purpurascens L.	purple milkweed	9	
Asclepias quadrifolia Jacq.	four-leaf milkweed	2	V
Asclepias syriaca L.	common milkweed	9	V
Asclepias verticillata L.	whorled milkweed	7	
Asclepias viridiflora Raf.	green milkweed	7	
ASTERACEAE			
Achillea millefolium L. var. *millefolium*	common yarrow	1,5,7	
Ageratina altissima (L.) King & H.E. Robins.	white snakeroot	1,2	
= *Eupatorium rugosum* Houtt.			
Ambrosia artemisiifolia L.	common ragweed	2,7,9	
Ambrosia trifida L.	great milkweed	4,9	
Antennaria neglecta Greene	field pussytoes	7	
Antennaria parlinii Fern. ssp. *fallax* (Greene) Bayer & Stebbins	Parlin's pussytoes	1	
Antennaria parlinii Fern. ssp. *parlinii*	Parlin's pussytoes	2,6,7	
Antennaria plantaginifolia (L.) Richards.	plantain-leaf pussytoes	1,2,6	
**Anthemis arvensis* L.	corn camomile	9	
**Arctium minus* Bernh.	lesser burdock	9	
**Artemisia annua* L.	annual wormwood	4	V
**Artemisia vulgaris* L.	common wormwood	7,9	
Bidens aristosa (Michx.) Britt.	tickseed beggar-ticks	7,9	
= *Bidens polylepis* Blake			
Bidens frondosa L.	devil's beggar-ticks	2,5	
Bidens tripartita L.	three-lobe beggar-ticks	4	
**Carduus nutans* L.	musk thistle	9	
**Centaurea biebersteinii* DC.	spotted knapweed	7,9	
= *Centaurea maculosa* auct. non Lam.			
**Cichorium intybus* L.	chickory	9	
Cirsium discolor (Muhl. ex Willd.) Spreng.	field thistle	2,7	
Cirsium muticum Michx.	swamp thistle	5	
Cirsium pumilum (Nutt.) Spreng.	pasture thistle	2,7	
**Cirsium vulgare* (Savi) Ten.	bull thistle	9	
Conoclinium coelestinum (L.) DC.	mistflower	7,8	
= *Eupatorium coelestinum* L.			
Conyza canadensis (L.) Cronq.	horseweed	7,9	
= *Erigeron canadensis* L.			
Coreopsis tripteris L.	tall tickseed	7	V
Coreopsis verticillata L.	whorled coreopsis	2	
Doellingeria infirma (Michx.) Greene	cornel-leaf aster	1,2	
= *Aster infirmus* Michx.			
Eclipta prostrata (L.) L.	yerba-de-tajo	9	
= *Eclipta alba* (L.) Hassk.			
Elephantopus carolinianus Raeusch.	Carolina elephant's-foot	6	
Erechtites hieraciifolia (L.) Raf. ex DC.	fireweed	2,5,7	
Erigeron annuus (L.) Pers.	annual fleabane	9	
Erigeron strigosus Muhl. ex Willd.	daisy fleabane	2,7	
Eupatorium fistulosum Barratt	hollow Joe-Pye-weed	4,8	
Eupatorium hyssopifolium L.	hyssop-leaved thoroughwort	7	
Eupatorium perfoliatum L.	common boneset	7,8	
Eupatorium serotinum Michx.	late thoroughwort	7,9	
Eurybia divaricata (L.) Nesom	white wood aster	1,2	
= *Aster divaricatus* L.			
Eurybia schreberi (Nees) Nees	Schreber's aster	1,10	V,C
= *Aster schreberi* Nees			

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
ASTERACEAE (continued)			
Euthamia graminifolia (L.) Greene	grass-leaved goldenrod	5	
= *Solidago graminifolia* (L.) Salisb.			
Gamochaeta purpurea (L.) Cabrera	purple cudweed	9	
= *Gnaphalium purpureum* L.			
Helenium autumnale L.	common sneezeweed	8	
Helenium flexuosum Raf.	Southern sneezeweed	7	
Helianthus decapetalus L.	thin-leaved sunflower	4	
Helianthus divaricatus L.	woodland sunflower	2	
Heliopsis helianthoides (L.) Sweet	oxeye	9	
**Hieracium caespitosum* Dumort.	meadow hawkweed	2,5,6	
Hieracium gronovii L.	hairy hawkweed	2	
Hieracium scabrum Michx.	rough hawkweed	1	
Hieracium venosum L.	rattlesnake-weed	1,2	
**Iva annua* L.	annual sumpweed	9	V,C
Krigia dandelion (L.) Nutt.	false dandelion	2	
Krigia virginica (L.) Willd.	dwarf dandelion	7,10	
Lactuca canadensis L.	wild lettuce	9	
Lactuca floridana (L.) Gaertn.	Florida blue lettuce	4,9	
**Leucanthemum vulgare* Lam.	oxeye daisy	7,9	
= *Chrysanthemum leucanthemum* L.			
Liatris squarrosa (L.) Michx.	scaly blazing-star	7	
Mikania scandens (L.) Willd.	climbing hempweed	5,8	
Packera anonyma (Wood) W.A. Weber & A. Löve	Small's ragwort	7	V
= *Senecio anonymus* Wood			
Packera aurea (L.) A.& D. Löve	golden ragwort	4	
= *Senecio aureus* L.			
Packera paupercula (Michx.) A.& D. Löve	balsam ragwort	2,3,5,6,7	V,C
= *Senecio pauperculus* Michx.			
Prenanthes serpentaria Pursh	lion's-foot	1,2,6	
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt	blunt-leaf rabbit-tobacco	7,9	
= *Gnaphalium obtusifolium* L.			
Rudbeckia fulgida Ait.	orange coneflower	7	
Rudbeckia hirta L.	black-eyed Susan	7,9	
Rudbeckia laciniata L.	cutleaved coneflower	4	
Sericocarpus asteroides (L.) B.S.P.	toothed white-top aster	1	
= *Aster paternus* Cronq.			
Silphium trifoliatum L.	whorled rosinweed	6,7	
Solidago bicolor L.	white goldenrod	1	
Solidago caesia L.	bluestem goldenrod	1,2	
Solidago canadensis L.	Canadian goldenrod	7,9	
Solidago juncea Ait.	early goldenrod	3,5,7	
Solidago nemoralis Ait.	gray goldenrod	7	
Solidago ulmifolia Muhl. ex Willd.	elm-leaf goldenrod	2	
**Sonchus asper* (L.) Hill	spiny-leaf sowthistle	9	
**Sonchus oleraceus* L.	common sowthistle	9	
Symphyotrichum cordifolium (L.) Nesom	heart-leaved aster	2	V,C
= *Aster cordifolius* L.			
Symphyotrichum dumosum (L.) Nesom	bushy aster	7	
= *Aster dumosus* L.			
Symphyotrichum lanceolatum (Willd.) Nesom	panicled aster	4,5	
=*Aster lanceolatus* Willd.			
= *Aster simplex* Willd.			
Symphyotrichum lateriflorum (L.) A.& D. Löve	goblet aster	1,2,3,4,5,6	
= *Aster lateriflorus* (L.) Britt.			
Symphyotrichum pilosum (Willd.) Nesom	white heath aster	7	
= *Aster pilosus* Willd.			
Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom	crooked-stem aster	4	
= *Aster prenanthoides* Muhl. ex Willd.			
Symphyotrichum undulatum (L.) Nesom	wavy-leaved aster	1,2,4	
= *Aster undulatus* L.			
**Taraxacum officinale* G.H. Weber ex Wiggers	common dandelion	6,7,9	
**Tragopogon dubius* Scop.	meadow goat's-beard	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
ASTERACEAE (continued)			
Verbesina alternifolia (L.) Britt. ex Kearney	wingstem	2,3,4	
Verbesina occidentalis (L.) Walt.	yellow crownbeard	2,4	
Vernonia glauca (L.) Willd.	broad-leaf ironweed	2	
Vernonia noveboracensis (L.) Michx.	New York ironweed	8	
Xanthium strumarium L.	cocklebur	9	
BALSAMINACEAE			
Impatiens capensis Meerb.	spotted jewelweed	2,3,4,5,8	
Impatiens pallida Nutt.	pale jewelweed	4	
BERBERIDACEAE			
**Berberis thunbergii* DC.	Japanese barberry	1,2,4,6	
Caulophyllum thalictroides (L.) Michx.	blue cohosh	2	V,C
Podophyllum peltatum L.	may-apple	1,2,4	
BETULACEAE			
Betula lenta L.	sweet birch	1	
Betula nigra L.	river birch	4	
Carpinus caroliniana Walt.	American hornbeam	1,2,3,4,5,6	
Corylus americana Walt.	American hazelnut	1,2	
Ostrya virginiana (P. Mill.) K. Koch	eastern hop-hornbeam	1,2,10	
BORAGINACEAE			
**Buglossoides arvensis* (L.) I.M. Johnston = *Lithospermum arvense* L.	common borage	9	
Cynoglossum virginianum L.	wild comfrey	2	
**Echium vulgare* L.	common viper's-bugloss	9	
Hackelia virginiana (L.) I.M. Johnston	Virginia stickseed	2	
Lithospermum canescens (Michx.) Lehm.	hoary puccoon	7	V,C
Mertensia virginica (L.) Pers. ex Link	Virginia bluebells	4	
**Myosotis discolor* Pers.	yellow-and-blue forget-me-not	8	V,C
Myosotis macrosperma Engelm.	large-seeded forget-me-not	2	V
Myosotis verna Nutt.	spring forget-me-not	7	
BRASSICACEAE			
**Alliaria petiolata* (Bieb.) Cavara & Grande	garlic mustard	1,2,3,4	
Arabis lyrata L.	lyre-leaf rockcress	10	V
**Barbarea verna* (P. Mill.) Aschers.	early winter-cress	9	
**Barbarea vulgaris* Ait. f.	common winter-cress	7,9	
**Capsella bursa-pastoris* (L.) Medik.	common shepherd's-purse	9	
Cardamine concatenata (Michx.) Sw. = *Dentaria laciniata* Muhl. ex Willd.	cutleaf toothwort	2,4	
**Cardamine hirsuta* L.	hairy bittercress	4,9,10	
Cardamine pensylvanica Muhl. ex Willd.	Pennsylvania bittercress	3,5	
**Lepidium campestre* (L.) Ait. f.	field pepper-grass	9	
Lepidium virginicum L.	poor man's pepper-grass	9	
**Microthlaspi perfoliatum* (L.) F.K. Mey. = *Thlaspi perfoliatum* L.	perfoliate pennycress	9	
**Rorippa sylvestris* (L.) Bess.	creeping yellow-cress	4,8	
CALLITRICHACEAE			
Callitriche heterophylla Pursh	northern water-starwort	4,8	
CAMPANULACEAE			
Lobelia cardinalis L.	cardinal flower	4,8	
Lobelia inflata L.	Indian-tobacco	5,6	
Lobelia puberula Michx.	downy lobelia	2	
Lobelia siphilitica L.	great lobelia	4	
Lobelia spicata Lam.	spiked lobelia	2	
Triodanis perfoliata (L.) Nieuwl. = *Specularia perfoliata* (L.) A. DC.	Venus'-looking-glass	6	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
CAPRIFOLIACEAE			
**Lonicera japonica* Thunb.	Japanese honeysuckle	1,2,3,4,5,6	
**Lonicera maackii* (Rupr.) Herder	Amur honeysuckle	9	
**Lonicera morrowii* Gray	Morrow honeysuckle	2	
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli = *Sambucus canadensis* L.	common elderberry	3,4,5	
Symphoricarpos orbiculatus Moench	coral-berry	1,2,4,5,6	
Triosteum perfoliatum L.	perfoliate tinker's-weed	2	
Viburnum acerifolium L.	maple-leaf viburnum	1,2,6	
Viburnum prunifolium L.	smooth black-haw	1,2,3,4,5,6	
Viburnum recognitum Fern.	northern arrow-wood	1,2,3,5	
CARYOPHYLLACEAE			
**Dianthus armeria* L.	Deptford-pink	7	
Paronychia canadensis (L.) Wood	forked nailwort	2	
Paronychia fastigiata (Raf.) Fern.	cluster-stemmed nailwort	1	V,C
Silene caroliniana Walt. ssp. *pensylvanica* (Michx.) Clausen	wild pink	2,6	
**Silene latifolia* Poir. ssp. *alba* (P. Mill.) Greuter Burdet	wild campion	9	
Stellaria longifolia Muhl. ex Willd.	longleaf stitchwort	4	V,C
**Stellaria media* (L.) Vill.	common chickweed	4,7,9	
Stellaria pubera Michx.	giant chickweed	1,2,4	
CELASTRACEAE			
**Celastrus orbiculata* Thunb.	Oriental bittersweet	2	
Euonymus americana L.	American strawberry-bush	1,6	
Euonymus atropurpurea Jacq.	wahoo	4	
CHENOPODIACEAE			
**Chenopodium album* L.	white goosefoot	9	
CISTACEAE			
Lechea racemulosa Michx.	Illinois pinweed	9	
CLUSIACEAE			
Hypericum canadense L.	Canadian St. John's-wort	8	V,C
Hypericum gentianoides (L.) B.S.P.	orange-grass	9	
Hypericum gymnanthum Engelm. & Gray	clasping-leaved St. John's-wort	8	V,C
Hypericum hypericoides (L.) Crantz ssp. *multicaule* (Michx. ex Willd.) Robson = *Hypericum stragulum* P. Adams & Robson	St. Andrew's cross	1,2	
Hypericum mutilum L.	slender St. John's-wort	4,8	
**Hypericum perforatum* L.	common St. John's-wort	7	
Hypericum prolificum L.	shrubby St. John's-wort	1,2,7	
Hypericum punctatum Lam.	spotted St. John's-wort	4,9	
CONVOLVULACEAE			
Calystegia spithamaea (L.) Pursh	low bindweed	2	
**Ipomoea hederacea* Jacq.	ivy-leaved morning glory	9	
Ipomoea pandurata (L.) G.F.W. Mey.	big-root morning glory	1,2,7,9	
**Ipomoea purpurea* (L.) Roth	common morning glory	9	
CORNACEAE			
Cornus amomum P. Mill.	silky dogwood	4,8	
Cornus florida L.	flowering dogwood	1,2,3,6	
Nyssa sylvatica Marsh.	black gum	1,2,5	
CRASSULACEAE			
Sedum ternatum Michx.	wild stonecrop	1,2,10	
Penthorum sedoides L.	ditch-stonecrop	8	
DIPSACACEAE			
**Dipsacus fullonum* L.	common teasel	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
EBENACEAE			
Diospyros virginiana L.	persimmon	1,2,3,5,6,7	
ELAEAGNACEAE			
**Elaeagnus umbellata* Thumb. var. *parvifolia* (Royle) Schneid.	autumn-olive	2,6	V,C
ERICACEAE			
Gaylussacia baccata (Wangenh.) K. Koch	black huckleberry	1	
Kalmia latifolia L.	mountain-laurel	1	
Rhododendron periclymenoides (Michx.) Shinners	wild azalea	1	
Vaccinium pallidum Ait.	early lowbush blueberry	1,2,6	
Vaccinium stamineum L.	deerberry	1,2,6	
EUPHORBIACEAE			
Acalypha virginica L.	Virginia copperleaf	2,6	
Chamaesyce maculata (L.) Small	spotted spurge	9	
= *Euphorbia maculata* L.			
Chamaesyce nutans (Lag.) Small	eyebane	9	
= *Euphorbia nutans* Lag.			
Euphorbia corollata L.	flowering spurge	1,2,7	
FABACEAE			
**Albizia julibrissin* Durazz.	silk tree	9	
Amphicarpaea bracteata (L.) Fern.	American hog-peanut	2,4,6	
Baptisia tinctoria (L.) R. Br. ex Ait. f.	yellow wild-indigo	1	
Cercis canadensis L.	eastern redbud	1,2,6,7	
Chamaecrista fasciculata (Michx.) Greene	partridge-pea	6,7	
= *Cassia fasciculata* Michx.			
Chamaecrista nictitans (L.) Moench	wild sensitive senna	6,7	
= *Cassia nictitans* L.			
Clitoria mariana L.	Maryland butterfly-pea	1	
**Coronilla varia* L.	common crown-vetch	9	
Desmodium canescens (L.) DC.	hoary tick-trefoil	7	
Desmodium ciliare (Muhl. ex Willd.) DC.	hairy small-leaved tick-trefoil	7	
Desmodium glabellum (Michx.) DC.	Dillen tick-trefoil	7	
Desmodium laevigatum (Nutt.) DC.	smooth tick-trefoil	7,9	
Desmodium marilandicum (L.) DC.	Maryland tick-trefoil	7	
Desmodium nudiflorum (L.) DC.	naked-flowered tick-trefoil	1,2	
Desmodium paniculatum (L.) DC.	narrow-leaf tick-trefoil	2,7	
Desmodium perplexum Schub.	perplexing tick-trefoil	2	
Desmodium rotundifolium DC.	prostrate tick-trefoil	1,2,9	
Desmodium viridiflorum (L.) DC.	velvety tick-trefoil	7	
Gleditsia triacanthos L.	honey-locust	1,2	
**Kummerowia stipulacea* (Maxim.) Makino	Korean bushclover	9	
= *Lespedeza stipulacea* Maxim.			
**Kummerowia striata* (Thunb.) Schindl.	Japanese bushclover	7,9	
= *Lespedeza striata* (Thunb.) Hook. & Arn.			
Lespedeza capitata Michx.	round-head bushclover	7	V,C
**Lespedeza cuneata* (Dum.-Cours.) G. Don	sericea bushclover	7,9	
Lespedeza hirta (L.) Hornem.	hairy bushclover	1,7	
Lespedeza procumbens Michx.	trailing bushclover	2,7	
Lespedeza repens (L.) W. Bart.	creeping bushclover	1,2	
Lespedeza violacea (L.) Pers.	wand bushclover	1,2	
= *Lespedeza intermedia* sensu Clewell, 1966			
Lespedeza virginica (L.) Britt.	slender bushclover	7	
**Lotus corniculatus* L.	bird's foot trefoil	7	V,C
**Melilotus officinalis* (L.) Lam.	sweet clover	2	
Robinia pseudoacacia L.	black locust	9	
Senna hebecarpa (Fern.) Irwin & Barneby	northern wild senna	8	
= *Cassia hebecarpa* Fern.			
Strophostyles umbellata (Muhl. ex Willd.) Britt.	pink wild-bean	7	
Stylosanthes biflora (L.) B.S.P.	pencilflower	9	
Tephrosia virginiana (L.) Pers.	goat's-rue	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
FABACEAE (continued)			
**Trifolium arvense* L.	rabbit-foot clover	7	
**Trifolium campestre* Schreb.	low hop clover	7	
**Trifolium hybridum* L.	alsike clover	7	
**Trifolium pratense* L.	red clover	7,9	
Trifolium reflexum L.	buffalo clover	2	V
**Trifolium repens* L.	white clover	2,9	
Vicia caroliniana Walt.	Carolina wood vetch	1,2	
**Vicia cracca* L.	tufted vetch	9	
**Vicia sativa* L.	spring vetch	9	
**Vicia tetrasperma* (L.) Schreb.	lentil vetch	9	
FAGACEAE			
**Castanea mollissima* Blume	Chinese chestnut	9	
Fagus grandifolia Ehrh.	American beech	1	
Quercus alba L.	white oak	1,2,5,6	
Quercus bicolor Willd.	swamp white oak	3,5	V
Quercus coccinea Muenchh.	scarlet oak	1,2,6	
Quercus falcata Michx.	Southern red oak	1,2,6	
Quercus muehlenbergii Engelm.	chinkapin oak	2	V,C
Quercus palustris Muenchh.	pin oak	2,3,4,5	
Quercus prinus L.	chestnut oak	1,2	
= *Quercus montana* Willd.			
Quercus rubra L.	red oak	1,2,6	
Quercus shumardii Buckl.	Shumard's oak	4	
Quercus stellata Wangenh.	post oak	2	
Quercus velutina Lam.	black oak	1,2,6	
FUMARIACEAE			
Corydalis flavula (Raf.) DC.	yellow corydalis	2,4	
Dicentra cucullaria (L.) Bernh.	Dutchman's breeches	4	
GENTIANACEAE			
Gentiana clausa Raf.	closed gentian	8	
Sabatia angularis (L.) Pursh	square-stemmed rose-pink	7	
GERANIACEAE			
Geranium maculatum L.	wild geranium	2	
HALORAGACEAE			
Myriophyllum sibiricum Komarov	common water-milfoil	8	V,C
= *Myriophyllum exalbescens* Fern.			
Proserpinaca palustris L.	common mermaid-weed	8	V,C
HAMAMELIDACEAE			
Hamamelis virginiana L.	witch-hazel	1,2	
HYDRANGEACEAE			
Hydrangea arborescens L.	wild hydrangea	1,2,10	
HYDROPHYLLACEAE			
Hydrophyllum virginianum L.	Virginia waterleaf	2,4	
JUGLANDACEAE			
Carya alba (L.) Nutt. ex Ell.	mockernut hickory	1,2,3,5,6	
= *Carya tomentosa* (Lam. ex Poir.) Nutt.			
Carya cordiformis (Wangenh.) K. Koch	bitternut hickory	1,2,3,4,5,6	
Carya glabra (P. Mill.) Sweet	pignut hickory	1,2,5,6	
Carya ovalis (Wangenh.) Sarg.	red hickory	1,2	
Juglans cinerea L.	butternut	2	
Juglans nigra L.	black walnut	2,4	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
LAMIACEAE			
**Chaiturus marrubiastrum* (L.) Reichenb. = *Leonurus marrubiastrum* L.	lion's-tail	6	
**Clinopodium vulgare* L. = *Satureja vulgaris* (L.) Fritsch	wild basil	9	
Cunila origanoides (L.) Britt.	common dittany	1,2	
**Glechoma hederacea* L.	ground-ivy	4	
Hedeoma pulegioides (L.) Pers.	American pennyroyal	2	
Isanthus brachiatus (L.) B.S.P.	false pennyroyal	10	V,C
**Lamium purpureum* L.	purple deadnettle	9	
Lycopus americanus Muhl. ex W. Bart.	American bugleweed	8	
Lycopus uniflorus Michx.	northern bugleweed	3	
Lycopus virginicus L.	Virginia bugleweed	3,5,9	
Mentha arvensis L.	wild mint	9	
**Mentha* × *piperita* L. (pro sp.) [*aquatica* × *spicata*]	peppermint	4	
**Nepeta cataria* L.	catnip	9	
**Perilla frutescens* (L.) Britt.	beef-steak plant	4	
Prunella vulgaris L. ssp. *lanceolata* (W. Bart.) Hultén	American self-heal	3,7	
Pycnanthemum incanum (L.) Michx.	hoary mountain-mint	7	
Pycnanthemum tenuifolium Schrad.	narrow-leaved mountain-mint	2,3,5,7	
Salvia lyrata L.	lyre-leaf sage	2	
Scutellaria elliptica Muhl. ex Spreng.	hairy skullcap	1,2	
Scutellaria integrifolia L.	helmet-flower	1,2,5,7	
Scutellaria lateriflora L.	mad dog skullcap	3	
Scutellaria nervosa Pursh	veined skullcap	1,3,4	V,C
Scutellaria parvula Michx. var. *missouriensis* (Torr.) Goodman & Lawson = *Scutellaria leonardii* Epling	shale-barren skullcap	2,9	V
Stachys pilosa Nutt. var. *arenicola* (Britt.) G. Mulligan & D. Munro	marsh hedgenettle	5,7	V,C
Stachys tenuifolia Willd.	smooth hedgenettle	8	V
Teucrium canadense L.	American germander	4,8,9	
Trichostema dichotomum L.	blue-curls	7,9	
LAURACEAE			
Lindera benzoin (L.) Blume	spicebush	2,3,4,5,6	
Sassafras albidum (Nutt.) Nees	sassafras	1,2,6	
LIMNANTHACEAE			
Floerkea proserpinacoides Willd.	false mermaid-weed	2,4	
LINACEAE			
Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fern.	wild flax	9	
LYTHRACEAE			
Cuphea viscosissima Jacq.	blue waxweed	9	
MAGNOLIACEAE			
Liriodendron tulipifera L.	tulip-tree	1,2,4,6	
MALVACEAE			
**Malva neglecta* Wallr.	dwarf cheeseweed	9	
**Sida spinosa* L.	prickly mallow	9	
MENISPERMACEAE			
Menispermum canadense L.	Canada moonseed	2	
MOLLUGINACEAE			
**Mollugo verticillata* L.	green carpetweed	9	
MONOTROPACEAE			
Monotropa uniflora L.	Indian-pipe	1,2	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
MORACEAE			
**Morus alba* L.	white mulberry	2,6	
Morus rubra L.	red mulberry	2,3	
OLEACEAE			
Chionanthus virginicus L.	fringetree	2	
Fraxinus americana L.	white ash	1,2,6,7	
Fraxinus pennsylvanica Marsh.	green ash	3,4,5	
ONAGRACEAE			
Circaea lutetiana L.	enchanter's nightshade	2,3,4,5	
Gaura biennis L.	biennial gaura	9	
Ludwigia alternifolia L	alternate-leaved seedbox	8	
Ludwigia palustris (L.) Ell.	marsh seedbox	3,6	
Oenothera fruticosa L.	narrow-leaved sundrops	5,7	
Oenothera perennis L.	small sundrops	2	
OROBANCHACEAE			
Conopholis americana (L.) Wallr. f.	squawroot	1	
Orobanche uniflora L.	one-flowered cancer-root	1	V
OXALIDACEAE			
Oxalis dillenii Jacq.	slender yellow woodsorrel	1,2,5,6	
Oxalis stricta L.	upright yellow woodsorrel	2,4	
Oxalis violacea L.	violet woodsorrel	2,6	
PAPAVERACEAE			
Sanguinaria canadensis L.	bloodroot	1,2	
PLANTAGINACEAE			
**Plantago aristata* Michx.	large-bracted plantain	7,9	
**Plantago lanceolata* L.	English plantain	7,9	
**Plantago rugelii* Dcne.	pale plantain	9	
Plantago virginica L.	Virginia plantain	7	
PLATANACEAE			
Platanus occidentalis L	sycamore	4	
POLYGALACEAE			
Polygala sanguinea L.	field milkwort	8	
Polygala verticillata L.	whorled milkwort	7,9	
POLYGONACEAE			
**Polygonum arenastrum* Jord. ex Boreau = *Polygonum aviculare* var. *arenastrum* (Jord. ex Boreau) Rouy	oval-leaf knotweed	9	
**Polygonum caespitosum* Blume var. *longisetum* (de Bruyn) A.N. Steward	long-bristled smartweed	2,3,4	
Polygonum hydropiperoides Michx.	mild water-pepper	3	V,C
Polygonum pensylvanicum L.	Pennsylvania smartweed	5	
**Polygonum persicaria* L.	lady's thumb	5	
Polygonum punctatum Ell.	dotted smartweed	3	
Polygonum sagittatum L.	arrow-leaved tearthumb	5,8	
Polygonum scandens var. *cristatum* (Engelm. & Gray) Gleason	crested false-buckwheat	2	
Polygonum tenue Michx.	slender knotweed	7,10	
Polygonum virginianum L.	Virginia knotweed	2,3,4	
**Rumex acetosella* L.	sheep sorrel	7,9	
**Rumex crispus* L.	curly dock	3,9	
**Rumex obtusifolius* L.	bitter dock	5,9	
Rumex verticillatus L.	swamp dock	3	
PORTULACACEAE			
Claytonia virginica L.	spring beauty	2,4	
**Portulaca oleracea* L.	common purslane	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
PRIMULACEAE			
Lysimachia ciliata L.	fringed loosestrife	3,4,5,6	
Lysimachia quadriflora Sims	whorled loosestrife	1,9	
Samolus valerandi L. ssp. *parviflorus* (Raf.) Hultén	water pimpernel	2	
= *Samolus parviflorus* Raf.			
PYROLACEAE			
Chimaphila maculata (L.) Pursh	spotted wintergreen	1,6	
Chimaphila umbellata (L.) W. Bart.	pipsissewa	1	
RANUNCULACEAE			
Actaea racemosa L.	black bugbane	1,2	
= *Cimicifuga racemosa* (L.) Nutt.			
Anemone quinquefolia L.	wood anemone	1	
Anemone virginiana L.	thimbleweed	6	
Aquilegia canadensis L.	wild columbine	10	
Clematis ochroleuca Ait.	curly-heads	2	
**Clematis terniflora* DC.	Japanese virgin's-bower	6	V,C
= *Clematis dioscoreifolia* Levl. & Vaniot			
Hepatica nobilis Schreber var. *obtusa* (Pursh) Steyermark	round-lobed hepatica	1,2	
= *Hepatica americana* (DC.) Ker-Gawl.			
Ranunculus abortivus L.	kidneyleaf crowfoot	2,3,4,5,6	
**Ranunculus bulbosus* L.	bulbous buttercup	7	
Ranunculus hispidus Michx. var. *caricetorum* (Greene) T. Duncan	swamp buttercup	3,5	V,C
= *Ranunculus septentrionalis* Poiret			
Ranunculus hispidus Michx. var. *hispidus*	bristly buttercup	2	
Ranunculus micranthus Nutt.	rock buttercup	2	
Ranunculus recurvatus Poir.	hooked crowfoot	2,4	
Thalictrum dioicum L.	early meadowrue	1,10	
Thalictrum revolutum DC.	skunk meadowrue	2	V,C
Thalictrum thalictroides (L.) Eames & Boivin	rue-anemone	1,2	
= *Anemonella thalictroides* (L.) Spach			
RHAMNACEAE			
Ceanothus americanus L.	New Jersey tea	9	
ROSACEAE			
Agrimonia parviflora Ait.	small-flowered agrimony	3,5,8	
Agrimonia pubescens Wallr.	downy agrimony	2	
Agrimonia rostellata Wallr.	woodland agrimony	2	
Amelanchier arborea (Michx. f.) Fern.	downy serviceberry	1,2,6	
Amelanchier laevis Wieg.	smooth serviceberry	1,2	
Amelanchier stolonifera Wieg.	low serviceberry	3	
Crataegus flabellata (Spach) Kirchn.	fan-leaf hawthorn	1	
Crataegus intricata Lange	Copenhagen hawthorn	2	
Crataegus punctata Jacq.	dotted hawthorn	6	
**Duchesnea indica* (Andr.) Focke	Indian strawberry	9	
Fragaria virginiana Duchesne	wild strawberry	7	
Geum canadense Jacq.	white avens	2,3,4,5,6	
Geum virginianum L.	cream avens	1,2	V,C
Malus angustifolia (Ait.) Michx.	southern crabapple	2	
**Malus pumila* P. Mill.	common apple	9	
Physocarpus opulifolius (L.) Maxim.	ninebark	7	V
Potentilla canadensis L.	Canada cinquefoil	1,2	
**Potentilla recta* L.	upright cinquefoil	7	
Potentilla simplex Michx.	common cinquefoil	7	
Prunus americana Marsh.	American wild plum	6	
Prunus angustifolia Marsh.	Chickasaw plum	6	
**Prunus avium* (L.) L.	sweet cherry	1,2,6	
**Prunus domestica* L.	European plum	9	V
Prunus serotina Ehrh.	wild black cherry	1,2,4,5,6	
**Pyrus communis* L.	common pear	9	
Rosa carolina L.	pasture rose	1,2,5,6,7,9	
**Rosa multiflora* Thunb. ex Murr.	multiflora rose	2,4,5,6,7	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
ROSACEAE (continued)			
Rubus allegheniensis Porter	Allegheny blackberry	2	
Rubus argutus Link	prickly blackberry	2,6	
Rubus cuneifolius Pursh	sand blackberry	7	
Rubus flagellaris Willd.	Northern dewberry	1,2,3,5,6,7	
Rubus occidentalis L.	black raspberry	2	
Spiraea alba Du Roi var. *latifolia* (Ait.) Dippel	broad-leaved meadowsweet	8	V
= *Spiraea latifolia* (Ait.) Borkh.			
**Spiraea* hybrid	a cultivated hybrid spiraea	8	V
RUBIACEAE			
Cephalanthus occidentalis L.	common buttonbush	3,8	
**Cruciata pedemontana* (Bellardi) Ehrend.	Piedmont bedstraw	7	V
= *Galium pedemontanum* (Bellardi) All.			
Diodia teres Walt.	buttonweed	7,9,10	
Galium aparine L.	cleavers	2,3,4,5	
Galium circaezans Michx.	forest bedstraw	1,2	
Galium concinnum Torr. & Gray	shining bedstraw	2,3	
Galium obtusum Bigelow ssp. *filifolium* (Wieg.) Puff	Carolina bedstraw	3	
Galium obtusum Bigelow ssp. *obtusum*	bluntleaf bedstraw	3,5	
Galium pilosum Ait.	hairy bedstraw	1,2,6,7	
Galium tinctorium (L.) Scop.	stiff marsh bedstraw	3	
Galium triflorum Michx.	sweet-scented bedstraw	1,2,4,5,6	
Houstonia caerulea L.	bluets	2,4	
= *Hedyotis caerulea* (L.) Hook.			
Houstonia purpurea L.	large summer bluets	1,2,6	
= *Hedyotis purpurea* (L.) Torr. & Gray			
Mitchella repens L.	partridge-berry	1,2,6	
RUTACEAE			
Zanthoxylum americanum P. Mill.	northern prickly-ash	2,3	V
SALICACEAE			
Salix nigra Marsh.	black willow	8	
SANTALACEAE			
Comandra umbellata (L.) Nutt.	bastard toadflax	1	
SAURURACEAE			
Saururus cernuus L.	lizard's tail	3	
SAXIFRAGACEAE			
Heuchera americana L.	American alumroot	1,2,10	
Saxifraga virginiensis Michx.	early saxifrage	1,10	
SCROPHULARIACEAE			
Agalinis purpurea (L.) Pennell	large purple false-foxglove	7	V
Agalinis tenuifolia (Vahl) Raf.	slender false-foxglove	7	
Aureolaria pedicularia (L.) Raf. var. *intercedens* Pennell	fern-leaved yellow foxglove	1	V
Aureolaria virginica (L.) Pennell	downy yellow foxglove	2	
Buchnera americana L.	blue-hearts	7	
Chelone glabra L.	white turtlehead	3	
Gratiola neglecta Torr.	clammy hedge-hyssop	5,6	
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider	false-pimpernel	8	
Lindernia dubia (L.) Pennell var. *dubia*	long-stalked false-pimpernel	4,8	
Mimulus alatus Ait.	winged monkey-flower	3	
Mimulus ringens L.	monkey-flower	8	
Penstemon digitalis Nutt. ex Sims	foxglove beardtongue	9	
Penstemon hirsutus (L.) Willd.	hairy beardtongue	7	V
Penstemon laevigatus Ait.	smooth beardtongue	2,3	
**Verbascum blattaria* L.	moth mullein	9	
**Verbascum thapsus* L.	great mullein	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
SCROPHULARIACEAE (continued)			
**Veronica arvensis* L.	corn speedwell	9	
**Veronica hederifolia* L.	ivy-leaf speedwell	4	
Veronica officinalis L.	common speedwell	7	
Veronica peregrina L.	purslane speedwell	9	
**Veronica persica* Poir.	bird's-eye speedwell	9	
**Veronica serpyllifolia* L. ssp. *serpyllifolia*	thyme-leaved speedwell	9	
SIMAROUBACEAE			
**Ailanthus altissima* (P. Mill.) Swingle	tree-of-heaven	6	
SOLANACEAE			
**Datura stramonium* L.	Jimson-weed	9	
Physalis longifolia Nutt. var. *subglabrata* (Mackenzie & Bush) Cronq.	smooth ground-cherry	7	
Physalis virginiana P. Mill.	Virginia ground-cherry	2	
Solanum carolinense L.	Carolina horse-nettle	7,9	
**Solanum dulcamara* L.	climbing nightshade	8	
STAPHYLEACEAE			
Staphylea trifolia L.	bladdernut	2,4	
ULMACEAE			
Celtis laevigata Willd.	common hackberry	6	
Celtis occidentalis L.	sugarberry	1,2,3,4,5	
Celtis tenuifolia Nutt.	Georgia hackberry	3	V,C
Ulmus americana L.	American elm	1,2,3,4,5	
Ulmus rubra Muhl.	slippery elm	2,4,6	
URTICACEAE			
Boehmeria cylindrica (L.) Sw.	false nettle	3,4	
Laportea canadensis (L.) Weddell	wood nettle	4	
Parietaria pensylvanica Muhl. ex Willd.	Pennsylvania pellitory	2,10	
Pilea pumila (L.) Gray	greenfruit clearweed	2,3	
VALERIANACEAE			
Valerianella radiata (L.) Dufr.	beaked cornsalad	7	
VERBENACEAE			
Phryma leptostachya L.	lopseed	1,2	
Verbena hastata L.	blue vervain	8	
Verbena simplex Lehm.	narrow-leaved vervain	7	
Verbena urticifolia L.	white vervain	4	
VIOLACEAE			
Hybanthus concolor (T.F. Forst.) Spreng.	green violet	2	V,C
Viola cucullata Ait.	marsh blue violet	3	
Viola pubescens Ait. var. *pubescens*	downy yellow violet	4	
Viola pubescens Ait. var. *scabriuscula* Schwein. ex Torr. & Gray	smooth yellow violet	4	
= *Viola eriocarpon* (Nutt.) Schwein. var. *leiocarpon* Fern. & Wieg.			
= *Viola pensylvanica* Michx.			
Viola sagittata Ait.	arrow-leaved violet	1,7	
Viola sororia Willd.	common blue violet	1,2,4,6	
Viola striata Ait.	striped violet	2,4	
Viola triloba Schwein. var. *triloba*	cleft violet	1,2	
VITACEAE			
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	1,2,3,4,5,6,10	
Vitis aestivalis Michx. var. *aestivalis*	summer grape	1,2,5	
Vitis aestivalis Michx. var. *bicolor* Deam	silverleaf grape	1	
Vitis vulpina L.	winter grape	1,2,3,4,5,6	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
ANGIOSPERMAE: MONOCOTYLEDONEAE			
AGAVACEAE			
Yucca filamentosa L.	common yucca	9	
ALISMATACEAE			
Alisma subcordatum Raf.	broad-leaved water-plantain	3,5	
ARACEAE			
Arisaema dracontium (L.) Schott	green dragon	2,3	
Arisaema triphyllum (L.) Schott	Jack-in-the-pulpit	1,2,3,4,5	
COMMELINACEAE			
**Commelina communis* L.	Asiatic dayflower	9	
Commelina virginica L.	Virginia dayflower	3,4	
**Murdannia keisak* (Hassk.) Hand.-Maz.	marsh dewflower	4,8	V,C
CYPERACEAE			
Carex albicans Willd. ex Spreng. var. *australis* (Bailey) J. Rettig = *Carex physorhyncha* Liebm.	bellow-beaked sedge	1,2,4,6	
Carex amphibola Steud.	narrow-leaved sedge	1,2	V
Carex annectens (Bickn.) Bickn.	yellow-fruited sedge	5	
Carex blanda Dewey	woodland sedge	2,3,4,6	
Carex brevior (Dewey) Mackenzie	short-beak sedge	3	V,C
Carex bushii Mackenzie	Bush's sedge	7,8	V
Carex caroliniana Schwein.	Carolina sedge	3,4	
Carex cephalophora Muhl. ex Willd.	oval-leaved sedge	1,2,3,6	
Carex communis Bailey	fibrous-root sedge	1,10	
Carex digitalis Willd.	slender wood sedge	1,2	
Carex festucacea Schkuhr ex Willd.	fescue sedge	3,5,8	V,C
Carex frankii Kunth	Frank sedge	3,5,6	
Carex glaucodea Tuckerman ex Olney	flaccid sedge	2,5,6	
Carex gracilescens Steud.	slender sedge	3,5	
Carex granularis Muhl. ex Willd.	meadow sedge	3,5	
Carex grayi Carey	Asa Gray sedge	3,4	V
Carex grisea Wahlenb.	ambiguous sedge	3,4,5	
Carex hirsutella Mackenzie = *Carex complanata* Torr. & Hook. var *hirsuta*(Willd.) Gleason	hirsute sedge	1,2,5,6	
Carex intumescens Rudge	bladder sedge	3	V
Carex jamesii Schwein.	Nebraska sedge	2,4	V
Carex laevivaginata (Kukenth.) Mackenzie	smooth-sheath sedge	5,8	
Carex laxiflora Lam.	loose-flowered sedge	1,2	
Carex louisianica Bailey	Louisiana sedge	3	V,C
Carex lupulina Muhl. ex Willd.	hop sedge	3,8	V,C
Carex lurida Wahlenb.	sallow sedge	3,8	
Carex meadii Dewey	Mead's sedge	7	V
Carex muehlenbergii Schkuhr ex Willd.	Muehlenberg's sedge	5	
Carex nigromarginata Schwein.	black-edge sedge	1,2	
Carex normalis Mackenzie	greater straw sedge	4,8	V
Carex oligocarpa Schkuhr ex Willd.	eastern few-fruit sedge	2	V,C
Carex pellita Muhl ex Willd. = *Carex lanuginosa* auct. non Michx.	woolly sedge	5	V,C
Carex pensylvanica Lam.	Pennsylvania sedge	1	
Carex platyphylla Carey	broad-leaved sedge	1	V
Carex radiata (Wahlenb.) Small	stellate sedge	3,4,5	
Carex rosea Schkuhr ex Willd.	rosy sedge	2	
Carex scoparia Schkuhr ex Willd.	pointed broom sedge	8	
Carex squarrosa L.	squarrose sedge	3,5	
Carex stipata Muhl. ex Willd. var. *maxima* Chapman = *Carex uberior* (C. Mohr) Mackenzie	large stalk-grain sedge	3	V
Carex stipata Muhl. ex Willd. var. *stipata*	stalk-grain sedge	3,8	
Carex stricta Lam.	tussock sedge	5	
Carex styloflexa Buckl.	bend sedge	2	
Carex swanii (Fern.) Mackenzie	Swan sedge	1	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
CYPERACEAE (continued)			
Carex tonsa (Fern.) Bickn.	shaved sedge	1	
= *Carex umbellata* var. *tonsa* Fern.			
Carex tribuloides Wahlenb.	blunt broom sedge	3,5	
Carex typhina Michx.	cat-tail sedge	3	
Carex vulpinoidea Michx.	fox sedge	3,5	
Carex willdenowii Schkuhr ex Willd.	Willdenow's sedge	1,2,6	
Cyperus echinatus (L.) Wood	globe flatsedge	7	
Cyperus lancastriensis Porter ex Gray	many-flowered flatsedge	8	V,C
Cyperus odoratus L.	rusty flatsedge	8	V,C
Cyperus strigosus L.	straw-colored flatsedge	8	
Eleocharis obtusa (Willd.) J.A. Schultes	blunt spikerush	5	
Eleocharis tenuis (Willd.) J.A. Schultes	slender spikerush	3,7	
Kyllinga pumila Michx.	thinleaf flatsedge	9	
= *Cyperus tenuifolius* (Steud.) Dandy			
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla	soft-stem bulrush	8	
= *Scirpus validus* Vahl			
Scirpus atrovirens Willd.	dark-green bulrush	3,5	
Scirpus cyperinus (L.) Kunth	woolgrass bulrush	8	
Scirpus georgianus Harper	Georgia bulrush	5	
Scirpus pendulus Muhl.	reddish bulrush	3,8	V
Scleria pauciflora Muhl. ex Willd.	fewflower nutrush	7	
DIOSCOREACEAE			
Dioscorea quaternata J.F. Gmel.	whorled wild yam	1,2,3,5	
HYDROCHARITACEAE			
Elodea nuttallii (Planch.) St. John	Nuttall waterweed	4	
IRIDACEAE			
Iris versicolor L.	blueflag	3	
Sisyrinchium mucronatum Michx.	Michaux blue-eyed grass	7	
JUNCACEAE			
Juncus acuminatus Michx.	sharp-fruited rush	5	
Juncus biflorus Ell.	grass-leaved rush	8	
Juncus brachycarpus Engelm.	short-fruited rush	8	V,C
Juncus dichotomus Ell.	forked rush	8	
Juncus dudleyi Wieg.	Dudley's rush	8	V,C
Juncus effusus L.	soft rush	3	
Juncus tenuis Willd.	slender rush	1,2,3,5	
Luzula bulbosa (Wood) Smyth & Smyth	southern woodrush	4	
Luzula echinata (Small) F.J. Herm.	spreading woodrush	6	
LEMNACEAE			
Lemna minor L.	lesser duckweed	8	
LILIACEAE			
Allium canadense L.	meadow onion	3,4	
**Allium vineale* L.	field garlic	7,9	
**Asparagus officinalis* L.	asparagus	7	
Erythronium americanum Ker-Gawl.	yellow trout-lily	4	
Hypoxis hirsuta (L.) Coville	eastern yellow stargrass	1,2	
Polygonatum biflorum (Walt.) Ell.	Solomon's-seal	1,2,4,10	
Maianthemum racemosum (L.) Link	false Solomon's-seal	1,2,6	
=*Smilacina racemosa* (L.) Desf.			
Uvularia perfoliata L.	perfoliate bellwort	2	
ORCHIDACEAE			
Corallorhiza odontorhiza (Willd.) Poir.	autumn coralroot	2	
Goodyera pubescens (Willd.) R. Br. ex Ait. f.	downy rattlesnake-plantain	1,6	
Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl.	large twayblade	2	
Platanthera lacera (Michx.) G. Don	ragged fringed orchid	7	
= *Habenaria lacera* (Michx.) R. Br.			

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
ORCHIDACEAE (continued)			
Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer = *Spiranthes gracilis* (Bigelow) Beck	southern slender ladies'-tresses	7	
Spiranthes tuberosa Raf. = *Spiranthes grayi* Ames	little ladies'-tresses	1	
Tipularia discolor (Pursh) Nutt.	cranefly orchid	2	
POACEAE			
Agrostis elliottiana J.A. Schultes	Elliott bentgrass	6,9	V
Agrostis hyemalis (Walt.) B.S.P.	winter bentgrass	7	
Agrostis perennans (Walt.) Tuckerman	autumn bentgrass	1,2,5,6	
Andropogon virginicus L.	broom-sedge	7	
**Anthoxanthum odoratum* L.	sweet vernal grass	7,9	
Aristida longespica Poir.	slip-spike three-awn grass	7,9	V
Aristida oligantha Michx.	prairie three-awn grass	7	
**Arthraxon hispidus* (Thunb.) Makino	joint-head arthraxon	4,8	
**Bromus commutatus* Schrad.	hairy brome grass	9	
**Bromus japonicus* Thunb. ex Murr.	Japanese brome grass	9	
Bromus pubescens Muhl. ex Willd.	common Eastern brome grass	1,2	
**Bromus racemosus* L.	spiked brome grass	7,9	
**Bromus sterilis* L.	poverty brome	9	V,C
Cinna arundinacea L.	wood reed grass	3,4,5	
**Cynodon dactylon* (L.) Pers.	Bermuda grass	9	
**Dactylis glomerata* L.	orchard grass	7	
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes	poverty oat-grass	1,2,3,5,6,7	
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*	tapered panic grass	3,7	
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark	tapered panic grass	5	V
Dichanthelium boscii (Poir.) Gould & C.A. Clark	Bosc's panic grass	1,2	
Dichanthelium clandestinum (L.) Gould	deer-tongue panic grass	4,8	
Dichanthelium commutatum (J.A. Schultes) Gould	variable panic grass	1,2	
Dichanthelium depauperatum (Muhl.) Gould	starved panic grass	1,7	
Dichanthelium dichotomum (L.) Gould	small-fruited panic grass	1,2,5,6	
Dichanthelium linearifolium (Scribn. ex Nash) Gould	narrow-leaf panic grass	2,5,7	
Dichanthelium scoparium (Lam.) Gould	velvet panic grass	8	V,C
Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould & C.A. Clark	roundfruit panic grass	4,9	
Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*	roundfruit panic grass	3,7	
**Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.	smooth crabgrass	9	
**Digitaria sanguinalis* (L.) Scop.	hairy crabgrass	9	
Echinochloa muricata (Beauv.) Fern.	rough barnyard grass	9	
**Eleusine indica* (L.) Gaertn.	Indian goosegrass	9	
Elymus hystrix L. var. *hystrix* = *Hystrix patula* Moench	bottlebrush grass	1,2,3,5	
Elymus riparius Wieg.	river-bank wild rye	3,4	V,C
Elymus virginicus L.	Virginia wild rye	2,4	
**Eragrostis cilianensis* (All.) Vign. ex Janchen	stinkgrass	9	
**Eragrostis curvula* (Schrad.) Nees	weeping lovegrass	9	
**Eragrostis pilosa* (L.) Beauv.	India lovegrass	9	
Eragrostis spectabilis (Pursh) Steud.	purple lovegrass	7	
Festuca rubra L.	red fescue	2,9	
Festuca subverticillata (Pers.) Alexeev	nodding fescue	1,2,3,4	
Glyceria septentrionalis A.S. Hitchc.	eastern mannagrass	3,8	V,C
Glyceria striata (Lam.) A.S. Hitchc.	fowl mannagrass	3,4,5	
**Holcus lanatus* L.	common velvet grass	6,7	
Hordeum pusillum Nutt.	little barley	9	
Leersia oryzoides (L.) Sw.	rice cutgrass	4	
Leersia virginica Willd.	Virginia cutgrass	3,5	
**Lolium pratense* (Huds.) S.J. Darbyshire = *Festuca elatior* L. p.p.	meadow fescue	2,3,5,7,9	
**Microstegium vimineum* (Trin.) A. Camus	eulalia	1,2,3,4,8	
Muhlenbergia frondosa (Poir.) Fern.	wirestem muhly	4	V,C
Muhlenbergia schreberi J.F. Gmel.	nimble-will	9	

GROUP/FAMILY SCIENTIFIC NAME	COMMON NAME	HABITATS	COUNTY RECORD
POACEAE (continued)			
Muhlenbergia sobolifera (Muhl. ex Willd.) Trin.	cliff muhly	2	
Panicum anceps Michx.	beaked panic grass	7	
Panicum capillare L.	witch grass	7	
Panicum dichotomiflorum Michx.	fall witch grass	7,9	
Panicum philadelphicum Bernh. ex Trin.	Philadelphia panic grass	7	V,C
Panicum rigidulum Bosc ex Nees var. *elongatum* (Pursh) Lelong	redtop panic grass	4,8	
Panicum rigidulum Bosc ex Nees var. *rigidulum*	tall flat panic grass	8	
Paspalum laeve Michx.	field paspalum	8	
Paspalum setaceum Michx.	slender paspalum	8	
Phalaris arundinacea L.	reed canary grass	8	V,C
**Phleum pratense* L.	meadow timothy	7	
**Poa annua* L.	annual bluegrass	7,9	
Poa autumnalis Muhl. ex Ell.	autumn bluegrass	3,4	V,C
**Poa compressa* L.	flat-stemmed bluegrass	1,2,3,5	
Poa cuspidata Nutt.	short-leaved bluegrass	1,2	
Poa pratensis L.	Kentucky bluegrass	3,7	
Poa sylvestris Gray	woodland bluegrass	4	
**Poa trivialis* L.	rough bluegrass	3,4,5	V,C
Schizachyrium scoparium (Michx.) Nash = *Andropogon scoparius* Michx.	little bluestem	7	
**Setaria faberi* Herrm.	nodding foxtail	9	
Setaria parviflora (Poir.) Kerguélen = *Setaria geniculata* auct. non (Wild.) Beauv.	bristly foxtail	7	
**Setaria pumila* (Poir.) Roemer & J.A. Schultes ssp. *pumila* = *Setaria glauca* (L.) Beauv. [under *Pennisetum glaucum* (L.) R. Br. in Kartesz (1999)]	yellow foxtail	9	
**Setaria viridis* (L.) Beauv.	green foxtail	7,9	
Sorghastrum nutans (L.) Nash	Indian grass	7	
Sphenopholis nitida (Biehler) Scribn.	shiny wedge grass	1,2	
Sphenopholis pensylvanica (L.) A.S. Hitchc.	swamp wedge grass	3	
Sporobolus vaginiflorus (Torr. ex Gray) Wood	sheathed dropseed	9	V,C
Tridens flavus (L.) A.S. Hitchc.	redtop	7,9	
Tripsacum dactyloides (L.) L.	northern gamagrass	9	
Vulpia octoflora (Walt.) Rydb.	slender fescue	6	
PONTEDERIACEAE			
Pontederia cordata L.	pickerel weed	4,8	
POTAMOGETONACEAE			
Potamogeton diversifolius Raf.	water-thread pondweed	8	
SMILACACEAE			
Smilax glauca Wlt.	whiteleaf greenbrier	1,2	
Smilax herbacea L.	common carrionflower	3,5	
Smilax pulverulenta Michx.	hairy carrionflower	2,4	
Smilax rotundifolia L.	common greenbrier	1,2,3,5,6	
Smilax tamnoides L. =*Smilax hispida* Muhl. ex Torr.	bristly greenbrier	2,4,6	V,C
TYPHACEAE			
Typha latifolia L.	broad-head cattail	8	

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Arthropod Community Heterogeneity in a Mid-Atlantic Forest Highly Invaded by Alien Organisms

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ABSTRACT

Pitfall traps obtained 11,611 arthropods of 255 species and morphospecies in seven classes, 28 orders, and 72 families at four sites in a low forest in Dyke Marsh Wildlife Preserve, Virginia, USA, during 2000 and 2001. The study sites had a total of 41 plant species, ranging from 10 to 33 species per site. Alien plant cover among the four sites ranged from 10-89%. Three alien plant species covered an average of 58% of the study sites. Abundance of arthropods varied significantly in some taxonomic groups below the phylum level. Ants, mites, spiders, and springtails were the more diverse and abundant arthropods captured. Spider and ant species richness was highest in a site with 89% alien plant cover. This site also had the highest abundance of collembolans and alien millipeds. Ant abundance was highest in two sites dominated by Asian Bittersweet and Japanese Honeysuckle. Ant diversity is a possible indicator for the diversity of the entire arthropod community on the forest floor. Our study suggests that alien invasive plants are altering terrestrial arthropod abundance and diversity in this national park.

Key words: terrestrial arthropods, biodiversity, community heterogeneity, eastern deciduous forest, alien invasive plants, *Ampelopsis brevipedunculata, Celastrus orbiculatus, Lonicera japonica*

INTRODUCTION

Arthropods are highly diverse and live in nearly every habitat on Earth. Trillions of them are alive at any one time. Class Insecta alone may have 5-30 million species (Erwin, 1982; Novotny et al., 2002). Although arthropods are major parts of many communities, to our knowledge there are no comprehensive studies of overall arthropod biodiversity (in terms of species richness and abundances) in particular communities, except for Borges' (1999) study in the Azores. Published community studies often have limited arthropod species lists that are dependent on the local researchers' fields of interest, or the presence of an endangered species, or both (Bossart & Carlton, 2002).

Many papers address the biodiversity of one or only a few selected arthropod taxa. For the North American Mid-Atlantic Region, such studies include those by Erwin (1981), Barrows (1986), Smith & Barrows (1987), Butler et al. (1999), Brown (2001), Kalhorn et al. (2003), and many references therein. There are a number of comprehensive, annotated lists of certain large arthropod taxa for particular regions including: Christiansen & Bellinger (1980), Henry & Froeschner (1988), and Krombien et al. (1984). Examples of lists that treat most insect groups are Britton (1920) for Connecticut, Leonard (1928) for New York, Proctor (1946) for Acadia National Park, Wray (1967) for North Carolina, Weissman & Kondratieff (1999) for Great Sand Dunes National Monument, and Haarstad (2003) for central Minnesota.

In view of the paucity of knowledge of arthropod communities worldwide, we examined the forest-floor arthropod community and its associated plants in a Mid-Atlantic forest.

METHODS

We conducted our study in the Dyke Marsh Wildlife Preserve (DMWP), Fairfax County, Virginia, USA, 38° 46' N, 77° 03' W, which contains a freshwater tidal

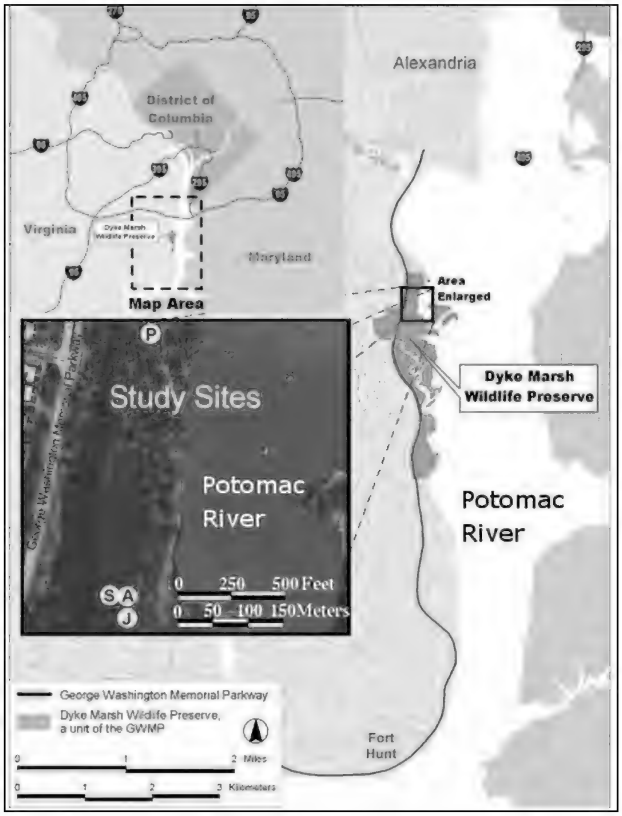

Fig. 1. Map of Dyke Marsh Wildlife Preserve showing locations of study sites.

marsh and bordering low deciduous forest and swamp forest along the Potomac River (Fig. 1). We sampled arthropods in four sites: three dominated by one of three species of alien plants, and one site dominated by native plants (Barrows & Kjar, 2004; keyword: DMWPss1). The alien Asiatic Bittersweet (*Celastrus orbiculatus*) was the most common plant cover in site A; alien Japanese Honeysuckle (*Lonicera japonica*), site J; alien Porcelainberry (*Ampelopsis brevi-pedunculata*), site P; and the native Sensitive Fern (*Onoclea sensibilis*), site S. In August 2000 we delineated a 10 x 10-m grid at each site with 100 1-m^2 plots using stakes and string. Each site had a 3-m-wide peripheral buffer zone with a flora similar to its central area. We censused each plot for all plants, including seedlings, using Brown & Brown (1984, 1992) and lists for DMWP in Xu (1991) and Haug (1993). Each plot was divided into four 0.5-m^2 quadrats. We determined plot plant coverage by counting the number of quadrats in which each plant species was rooted or by recording the presence or absence of a particular vine species in plots with dense vine cover.

To determine which arthropod species were present and test our null hypothesis that arthropod taxa did not differ in their abundances among the study sites, we used pitfall traps to collect arthropods on a warm, dry day during the third week of August, September, and October 2000 and June, July, August, September, and October 2001. During a trapping bout, we ran all traps during the same 24 h. Each site had 10 traps, each being in the central area of a randomly chosen 1-m^2 plot within the site. The trap comprised a large plastic cup (11.5-cm diameter x 13 cm deep), a small plastic cup (8-cm diameter x 10 cm deep), a funnel (11-cm top diameter and 2-cm bottom diameter), a thin plastic collar (16-cm outside diameter and 9.5-cm inside diameter), and a 32-cm^2 square wooden cover with four legs (2.5 x 2.5 x 4 cm). We closed the large cups with tightly fitting lids between trapping bouts. To prepare a trap for collecting arthropods, we opened its large cup, placed a small cup with 25 ml of 95% ethanol inside it, placed the collar over the large cup, placed a funnel on the collar, added a 5-mm deep layer of local soil over the collar, and centered the cover over the collar.

Although pitfall trapping cannot be used for absolute abundance estimates, it is the most accepted and time-efficient way to compare terrestrial arthropods among sites (Uetz et al., 1979; Porter & Savignano, 1990; Oliver & Beattie, 1996; Holway, 1998; Burger et al., 2001). Pitfall-trap catches of ants do not give a comprehensive view of the true abundance or diversity of ants within a site due to the social and behavioral differences in ant species. However, the random selection of plots within each site and the identical trapping regimes for each site allowed us to compare each site's trap catches within species and larger groups (e.g., Formicidae). Litter and vegetation architecture may also be a confounding factor when comparing pitfall catches in different habitats and must be taken into account (Greenslade, 1964).

We identified arthropods with the help of lab technicians and specialists, keys including those in Blatchley (1910, 1926), Bolton (1994), Borror et al. (1981), Christiansen & Bellinger (1980), Creighton (1950), Downie & Arnett (1996), and Henry et al. (1988), and digital images that we put online during specimen processing helped in rapid identification of common species (Barrows & Kjar, 2004). We excluded Acari from all quantitative analyses because their abundance depended on the amount of soil that inadvertently fell into a trap cup. Voucher specimens were deposited in the Arthropod Collection of the Laboratory of Entomology and Biodiversity at Georgetown University.

To test our null hypothesis, we used parametric and nonparametric analyses of variance (ANOVAs). For parametric analyses, we used raw or $\log_{10}(x+1)$-transformed data and the *post hoc* multiple-comparison Student-Newman-Keuls (SNK test). For nonparametric

analyses, we used the Kruskal-Wallis test and the *post hoc* multiple-comparison Tukey test on rank sums (for Diplopoda and *Ponera pennsylvanicus*). We used SPSS version 10.1.0 (SPSS 2000) for all tests except for the Tukey test which we performed using Zar's (1984) method. Each trap's catch for both years is combined to produce the total for a trap. Within each site the totals from the 10 traps were used to produce the mean number of a particular taxon per trap for that site.

To ascertain arthropod diversities, we used the 2-yr cumulative arthropod abundances per site and all sites combined to calculate the Shannon-Weaver index, $H' = -\Sigma\ (p_i \ln p_i)$, where p_i is the frequency of the ith species (Krohne, 1998) and an index of evenness, $E = H'/\ln S$, where S is the number of species. E approaches 1.0 as total abundance becomes more evenly distributed among all species. To compare species diversity between sites, we used the Community Coefficient of Similarity, $CC = 2\Sigma C/(A+B)$ (Uetz, 1976), which we modified with an additional term where $C = 1-|(pC_a - pC_b)|$ for abundance weighting; pC_a and pC_b are the proportions of each species shared by both sites, and A or B are the number of species at each site.

RESULTS

Each site varied in plant species richness and identity of its dominant plant species (Table 1). Site P had the most alien plant coverage (89%), followed, in descending order, by sites A, J, and S (Table 1). We could find no area of 10 x 10 m without alien plants in the forest. Site S had the most diverse plant community ($H' = 2.63$), followed by sites J, A, and P (Table 1). Twenty-nine plant species occurred in site S, with no species exceeding 25% of the total site coverage. One species (*A. brevipedunculata)* covered 71% of site P, which had the lowest H' and evenness *(E)* of the four sites. Site A had the highest species richness, but only three species (*C. orbiculatus*, *L. japonica*, and *Toxicodendron radicans,* Poison Ivy) totaled 67% of its coverage. This resulted in a 19% lower H' and 21% lower E than site S, although site S had four fewer species than site A.

Pitfall traps collected 11,611 individual arthropods of 255 species and morphospecies in seven classes, 28 orders, and 72 families (Appendix 1). Images of most species are in Barrows & Kjar (2004). Thirteen taxa (Araneae, Coleoptera, Collembola, Diplopoda, Formicidae, Isopoda, Orthoptera, five formicid species, and one hahniid spider species) had significantly different mean abundances among sites (Tables 2-4). Sites P and S had more spiders (Araneae) and beetles (Coleoptera) than sites A and J. Each site had a significantly different number of springtails (Collembola) in its traps than the other sites ($P \leq 0.05$, SNK test, Table 2). Millipeds and isopods were predominantly caught in site P (Table 2). All but four of the trapped millipeds were the alien, invasive julid *Ophyiulus pilosus*, native to Europe. Sites A and J had significantly higher numbers of ants than sites P and S ($P \leq 0.05$, SNK test, Table 2). Orthoptera had similar abundances at sites A, P, and S, but site J had significantly fewer individuals ($P \leq 0.05$, SNK test, Table 2).

Site P pitfalls caught the most ant species (16) and had the highest ant H' and E (Table 5). This site also yielded four ant species not caught at the other sites: *Amblyopone pallipes, Crematogaster pilosa, Myrmica emeryana,* and *M. punctiventris*. *Crematogaster cervasi* was captured only at site J and the only *Proceratium silaceum* were captured at site A. *Prenolepis imparis* accounted for >50% of all captured ants for sites A and J and 44% of the ants caught at site S. However at site P, 50% of all captured ants were *Paratrechina faisonensis*, whereas only 5% were *P. imparis* (Table 3).

The majority of captured arthropod groups did not vary significantly in abundance among sites ($P > 0.05$, ANOVA, Table 2). One-third of all groups had fewer than 20 representatives in the traps (Table 2). The total abundance of all arthropod groups did not vary significantly among sites ($P > 0.05$, ANOVA, Table 2). Of the 13 groups on which *post hoc* multiple comparisons tests could be run (excluding Formicidae as a group), six groups demonstrated that sites A and J are more similar to each other than to either site P or S (Tables 2-4).

Exclusion of ants from the diversity indices resulted in a 30% H' increase for sites A and J, compared to a 5% and 9% H' decrease for sites S and P, respectively (Table 5). Formicid Community Coefficient of Similarity (CC) mirrored the combined CCs of plant, spider, and higher taxa (Table 6). Sites A, J, and S were more similar to each other in species identity for Formicidae and plants than they were to site P. Plant and spider species composition differed greatly among sites (Tables 1, 4).

Spiders were diverse at all sites, although only two species were abundant (Table 4). Less than 60% of the spider species were caught at more than one site. The lycosid *Pirata zelotes* was the most abundant spider, followed by the hahniid *Neoantistea agilis* (Table 4). Sites A and J did not differ significantly in abundance of *N. agilis* and total spiders, but were significantly different from site S with regard to these taxa ($P \leq 0.05$, SNK test, Table 4). Site P had significantly more *N. agilis*, but not significantly more spiders as a group, than sites A and J ($P \leq 0.05$, SNK test, Table 4).

Table 1. Plant composition and diversity in four study sites, Dyke Marsh Wildlife Preserve, Virginia. Bolded names and values indicate alien plants. Underlined values indicate the most dominant plant in each site.

		Estimated percent cover per site (n = 10)			
Species	Common name	A	J	P	S
Acer rubrum	red maple	0.64	0.11	0	0.88
Ampelopsis brevipedunculata	**porcelainberry**	**0**	**0.46**	**71.25**	**1.32**
Aster sp.	aster	0	0	1.00	0
Berberis thunbergii	**Japanese barberry**	0	0	0	0.22
Botrychium virginianum	rattlesnake fern	0	0.34	0	0.66
Campsis radicans	trumpet creeper	0	0.23	0	0.22
Carya cordiformis	bitternut hickory	0.80	0.69	0	0
Carya sp.	hickory	1.29	0	0	0
Celastrus orbiculatus	**Asiatic bittersweet**	**51.13**	**13.97**	**10.07**	**8.33**
Celtis occidentalis	hackberry	0.16	0	0	0
Clematis terniflora	**Asian clematis**	**0.64**	**5.50**	0	**0.88**
Cornus florida	flowering dogwood	0	0	0.18	0.44
Dioscorea villosa	wild yam	0	0.11	0	1.75
Duchesnea indica	**Asian strawberry**	**0**	**0.46**	**0**	**0**
Eupatorium rugosum	snakeroot	0	0.57	0	3.29
Fraxinus americana	white ash	0	0.11	0	0
Fraxinus pennsylvanica	green ash	0	0.11	0	0
Galium obtusum	stiff bedstraw	0	0.23	0	0
Galium triflorum	sweet-scented bedstraw	0	0.69	0	0
Geum canadense	white avens	0	0.23	0	0
Ligustrum sp.	**privet**	**0**	**0.23**	**0**	**0.66**
Lindera benzoin	spicebush	5.31	4.70	0	6.36
Liquidambar styraciflua	sweetgum	0.48	0.34	0	0.44
Lonicera japonica	**Japanese honeysuckle**	**8.36**	**37.57**	**10.44**	**7.02**
Lonicera maackii	**Amur honeysuckle**	**1.29**	**1.15**	**0**	**0.44**
Lysimachia ciliata	fringed loosestrife	0	0	0	1.75
Onoclea sensibilis	sensitive fern	0	0.46	0	25.00
Parthenocissus quinquefolia	Virginia creeper	0.16	4.93	0	3.95
Prunus serotina	wild black cherry	0.48	3.78	0.55	1.32
Quercus phellos	willow oak	0.16	0.46	0	1.10
Quercus velutina	black oak	0	0.11	0	0.22
Rosa multiflora	**multiflora rose**	**1.29**	**0.23**	**0**	**2.63**
Rubus argutus	serrated-leaf blackberry	0.16	0.11	5.86	1.54
Sambucus canadensis	common elder	0	0	0.18	0.22
Sassafras albidum	sassafras	0	0.11	0	0
Smilax rotundifolia	round-leaf greenbrier	0	0	0	0.44
Toxicodendron radicans	poison ivy	8.84	16.15	0.73	8.33
Ulmus americana	American elm	0.32	0.80	0	1.97
Viburnum molle	smooth arrowwood	16.88	4.70	0.55	12.94
Viburnum prunifolium	black haw	1.45	0.23	0	5.70
Vitis sp.	grape	0.16	0.11	0	0
Total percent invasion†		77 ± 13	47 ± 21	89 ± 14	10 ± 12
Number of species		20	33	10	29
Shannon index of diversity (H')		1.68	2.13	1.04	2.63
Shannon index of evenness (E)		0.56	0.61	0.45	0.78

† Percent invasion (mean ±1SD) for each site determined from plant survey information. n = 100 plots per site.

Table 2. Number of arthropods (mean ± 1 SD) captured per pitfall trap (n = 10) at four study sites in Dyke Marsh Wildlife Preserve, Virginia.†

		Site			
Taxon	**Common name**	**A**	**J**	**P**	**S**
Araneae‡	Spiders	7.3 ± 4.4a	5.6 ± 2.7a	9.8 ± 3.8a,b	10.1 ± 2.8b
Blattaria	Cockroaches	0.2 ± 0.4	0.6 ± 1.1	0.3 ± 0.5	0.5 ± 0.7
Chilopoda	Centipedes	1.5 ± 1.9	2.7 ± 1.8	2 ± 2.6	0.9 ± 0.6
Coleoptera‡	Beetles	14 ± 3.6a	11 ± 2.2b	9.1 ± 3.1b	9.3 ± 1.7b
Collembola‡	Springtails	34.6 ± 9.4a	48.1 ± 11.9b	121.5 ± 28.2c	85.6 ± 17.1d
Dermaptera	Earwigs	0	0.2 ± 0.4	0	0.2 ± 0.6
Diplopoda‡	Millipedes	0.8 ± 1.0a	0.5 ± 1.0a	6.8 ± 3.8b	0.7 ± 0.7a
Diplura	Diplurans	1 ± 1.4	1.4 ± 1.8	0	0.6 ± 1.0
Diptera	Flies	6.1 ± 2.0	7.1 ± 2.7	9.2 ± 4.4	6.6 ± 2.8
Formicidae‡	Ants	152 ± 41.4a	137.6 ± 62.0a	40.1 ± 17.4b	58.5 ± 27.9b
Hemiptera	Bugs	1.4 ± 1.3	0.8 ± 0.9	0.7 ± 0.9	0.3 ± 0.7
Homoptera	Bugs	1.1 ± 0.6	1.3 ± 1.2	0.5 ± 0.5	1.5 ± 1.6
Hymenoptera§	Bees, Sawflies, Wasps	5.1 ± 2.3	9.1 ± 3.1	7.5 ± 5.8	6.6 ± 3.2
Isopoda‡	Sowbugs, Pillbugs, and kin	1.1 ± 0.7a	1.3 ± 0.9a	6.9 ± 6.3b	2.2 ± 1.5a
Isoptera	Termites	0.4 ± 0.7	0	0.1 ± 0.3	0
Lepidoptera	Butterflies, Moths	0.3 ± 0.7	0.2 ± 0.6	0.3 ± 0.5	0.3 ± 0.5
Neuroptera	Dustywings	0	0.1 ± 0.3	0	0
Opiliones	Harvestmen	9.2 ± 3.6	12.6 ± 5.6	9.7 ± 2.9	9.3 ± 3.4
Orthoptera‡	Crickets, Grasshoppers, and kin	19.9 ± 4.9a	13.9 ± 2.6b	22.3 ± 9.8a	23.6 ± 5.2a
Pseudoscorpiones	Pseudoscorpions	0.2 ± 0.4	0.8 ± 0.9	0	0.3 ± 0.5
Psocoptera	Barklice	0	0.6 ± 0.8	0	0.2 ± 0.4
Symphyla	Symphylans	0.4 ± 0.7	0.3 ± 0.7	0	0.3 ± 0.7
Thysanura	Bristletails	0.2 ± 0.4	0	0	0.1 ± 0.3
Thysanoptera	Thrips	0.4 ± 0.7	0.7 ± 0.7	0.1 ± 0.3	0.5 ± 0.5
Trichoptera	Caddisflies	0	0.2 ± 0.4	0	0.1 ± 0.3
Total Arthropods		257 ± 82.5	256 ± 106.3	246.9 ± 91.1	218.3 ± 74.7

† Within rows, means followed by different letters are significantly different from one another. We used a Tukey test for Diplopoda.
‡ $P \leq 0.05$.
§ Exclusive of Formicidae.

Table 3. Numbers of ants (mean ± 1 SD) captured per pitfall trap (n = 10) at four study sites in Dyke Marsh Wildlife Preserve, Virginia.

	Site			
Taxon	**A**	**J**	**P**	**S**
Acanthomyops sp.	0	0.2 ± 0.4	0	0.1 ± 0.3
Amblyopone pallipes	0	0	0.2 ± 0.4	0
Aphaenogaster rudis†	39.2 ± 37.2b	25.5 ± 9.4b	4.7 ± 5.4a	9.7 ± 7.3a
Camponotus castaneus	0.1 ± 0.3	0.2 ± 0.4	0.1 ± 0.3	0
Camponotus nearcticus	0.1 ± 0.3	0	0.1 ± 0.3	0
Camponotus pennsylvanicus	0.2 ± 0.4	0	0	0.1 ± 0.3
Camponotus subbarbartus	0.1 ± 0.3	0	0.1 ± 0.3	0
Crematogaster cerasi	0	0.1 ± 0.3	0	0
Crematogaster pilosa	0	0	1.2 ± 1.2	0
Lasius alienus†	1.8 ± 1.3b	5.6 ± 4.7a	6.6 ± 4.8a	5.0 ± 3.8a
Leptothorax curvispinosis	0.4 ± 0.7	1.3 ± 1.2	0.8 ± 1.0	0.8 ± 0.8
Myrmecina americana	1.1 ± 1.1	0.5 ± 0.5	1.3 ± 1.6	0.5 ± 1.0
Myrmica emeryana	0	0	0.3 ± 0.7	0
Myrmica punctiventris	0	0	0.7 ± 1.3	0
Paratrechina faisonensis†	25.5 ± 5.5b	20.2 ± 6.2a,b	19.7 ± 8.4a,b	12.6 ± 7.6a
Ponera pennsylvanicus†	0.5 ± 1.1	0.2 ± 0.6	1.9 ± 1.4	1.9 ± 1.7
Prenolepis imparis†	79.4 ± 40.2b	80.2 ± 55.7b	2.1 ± 1.8c	25.9 ± 15.4a
Proceratium silaceum	0.1 ± 0.3	0	0	0
Pyramica ohioensis	0	0.4 ± 1.3	0	0.1 ± 0.3
Pyramica rostrata	1.1 ± 1.0	1.7 ± 3.1	0.2 ± 0.4	0.2 ± 0.4
Stenamma brevicorne†	1.6 ± 1.8a	1.1 ± 0.9a	0.1 ± 0.3b	1.4 ± 1.6a
Stenamma impar	0.4 ± 0.7	0.4 ± 0.5	0	0.2 ± 0.6
Total ants	151 ± 41.4b	137 ± 62.0b	40 ± 17.4a	58 ± 27.9a

† $P \leq 0.05$. Within rows, means followed by different letters are significantly different from one another; *Ponera pennsylvanicus* sample size was too small for a *post hoc* analysis.

DISCUSSION

We found that abundances of some arthropod taxa were highly variable among sites. There were large differences in arthropod abundance and plant species richness between site P and the other three sites, and formicid CC may be a good indicator of changes in the entire terrestrial arthropod community in the forest. Small samples may have prevented us from finding many possible differences in arthropod abundance among sites (Table 2).

Site P, a forest opening evidently caused by a large tree fall, is markedly different from the other three sites and had the lowest plant H' and E (Table 2). A dense mat of the vigorous, alien vine *A. brevipedunculata* comprised 71% of the site's plant cover and appears to be maintaining the forest opening by excluding new tree seedlings and out-competing other plants for light, space, and other resources. Further, this vine may be excluding arthropods present in typical forest succession in the DMWP.

Plants can change soil chemistry by adding nutritive matter from their fallen parts and ectocrine substances and by removing soil nutrients and water. For example, in the Netherlands, the chemistry of decomposing leaves on a forest floor explained much of the variation in a collembolan community (Pinto et al., 1997). The abundance of litter-associated taxa such as Collembola, Diplopoda, Formicidae, and Isopoda in site P varied significantly from their abundances in the other sites. Site P had 359 more Collembola, and 60 more alien, invasive millipeds (*O. pilosus)* than any other site. Our ongoing DMWP research may identify which factors determine the distribution of *O. pilosus.* The presence of this milliped may be associated with the presence of *A. brevipedunculata* and its environmental effects.

Although ant abundance at site P was low, its ant diversity (*H'*) was the highest of all four sites (Table 5). We caught four ant species unique to site P, possibly because the highly competitive False Honey Ant (*P. impairs*) was rare at this site, although an associated increase in other ant abundance is not apparent (Table 3). Based on our methodology, we cannot rule out the possibility that this ant was more common at site P than our traps indicated. This ant may have been foraging mostly on *A. brevipedunculata* and other plants not on the ground where the traps could collect it. Decreases in normally abundant ant species may be a sign of change in the ecology of an area according to Lynch et al. (1980). In eastern Maryland, they found that this usually common ant is sensitive to high temperatures and often becomes inactive when temperatures exceed 26º C. Site P is noticeably warmer than the other sites when there is direct sunlight (pers. obs.), and the ground temperature may sometimes exceed that tolerated by *P. imparis*.

Sites P and S had low numbers of *Aphaenogaster rudis* and *P. imparis,* although there were significantly more *P. imparis* in the latter site. Site S is near a tidal channel and was periodically flooded during our study.The wet ground may have reduced the numbers of *P. imparis* and affected the arthropod community in other ways as well.

Composite CC values (where Formicidae are excluded) were nearly identical to formicid CC values (Table 6), and this may have important implications for future studies. We are currently working on a more comprehensive study of both soil and terrestrial arthropods and plan to evaluate whether a species-level

Table 4. Number of spiders (mean ± 1 SD) captured per pitfall trap (n = 10) at four study sites in Dyke Marsh Wildlife Preserve, Virginia.

	Site			
Species	**A**	**J**	**P**	**S**
Agelenopsis sp.	0.1 ± 0.3	0	0	0
Agroeca pratensis	0.1 ± 0.3	0	0	0
Anyphaena sp.	0	0	0	0.1 ± 0.3
Anyphaenidae spp.	0	0.1 ± 0.3	0.1 ± 0.3	0
Araneidae spp.	0.1 ± 0.3	0	0.1 ± 0.3	0.2 ± 0.4
Castianeira variata	0	0.2 ± 0.4	0.2 ± 0.4	0
Crustulina altera	0.1 ± 0.3	0.2 ± 0.4	0	0
Crustulina sp.	0.1 ± 0.3	0.1 ± 0.3	0	0.1 ± 0.3
Dictyna sp.	0	0.1 ± 0.3	0	0.3 ± 0.5
Drassyllus sp.	0.2 ± 0.4	0.6 ± 0.7	0.4 ± 0.5	0.2 ± 0.4
Dysdera crocata	0.1 ± 0.3	0	0.4 ± 0.7	0.1 ± 0.3
Eidmannella pallida	0.1 ± 0.3	0	0.3 ± 0.6	0
Erigoninae spp.	0.2 ± 0.4	0.2 ± 0.6	0.1 ± 0.3	0.2 ± 0.6
Euryopis argentea	0.2 ± 0.4	0.1 ± 0.3	0	0
Habrocestum pulex	0.2 ± 0.4	0.1 ± 0.3	0.4 ± 0.5	0.3 ± 0.5
Linyphiidae sp. a	0	0	0	0.1 ± 0.3
Linyphiidae sp. b	0.2 ± 0.4	0	0	0.5 ± 0.7
Linyphiidae sp. c	0	0	0.9 ± 1	0
Linyphiidae sp. d	0	0.1 ± 0.3	0	0
Linyphiidae sp. e	0	0	0.2 ± 0.4	0
Linyphiidae sp. f	0.1 ± 0.3	0	0.3 ± 0.5	0
Linyphiidae sp. g	0	0	0.1 ± 0.3	0
Linyphiinae spp.	0.8 ± 0.8	0.5 ± 0.5	0.8 ± 1.0	0.4 ± 0.5
Neoantistea agilis†	0.4 ± 0.7a	0.4 ± 0.7a	1.7 ± 1.1b	1.9 ± 1.4b
Neoscona domiciliorum	0	0	0	0.1 ± 0.3
Pardosa sp.	0	0.2 ± 0.4	0	0
Phrurotimpus borealis	0.1 ± 0.3	0.6 ± 0.5	0.4 ± 0.5	0
Phrurotimpus sp.	0	0.1 ± 0.3	0	0.3 ± 0.5
Pirata zelotes	3.1 ± 2.0	1.7 ± 1.5	2.5 ± 1.3	3.6 ± 1.7
Pisaurina sp.	0	0	0.1 ± 0.3	0
Schizocosa ocreata	0	0	0.1 ± 0.3	0
Scotinella redempta	0.5 ± 0.7	0.1 ± 0.3	0.3 ± 0.5	0.7 ± 0.5
Scotinella sp.	0.2 ± 0.4	0.1 ± 0.3	0.2 ± 0.4	0.2 ± 0.4
Sergiolus sp.	0	0.1 ± 0.3	0	0
Theridiidae sp.	0	0	0	0.1 ± 0.3
Xysticus sp.	0.4 ± 0.7	0	0.1 ± 0.3	0.7 ± 0.7
Zelotes sp.	0	0	0.1 ± 0.3	0
Total spiders†	7.3 ± 4.4a	5.6 ± 2.7a	9.8 ± 3.8a,b	10.1 ± 2.8b

† $P \leq 0.05$. Within rows, means followed by different letters are significantly different from one another.

Table 5. Shannon-Weaver index of diversity (*H'*) and Shannon index of evenness (*E*) for arthropod classes and orders, spiders, and ants caught at each site in Dyke Marsh Wildlife Preserve, Virginia.

	Site			
Arthropoda*	**A**	**J**	**P**	**S**
Arthropod abundance	2,568	2,567	2,469	2,183
No. of classes/orders (25 total)	20	22	16	22
H'	1.25	1.35	1.37	1.44
E	0.42	0.44	0.50	0.47
H' excluding Formicidae	1.73	1.77	1.24	1.36
E excluding Formicidae	0.57	0.57	0.44	0.43
Araneae (Spiders)				
Spider abundance	73	56	98	101
Number of species (37 total)	20	19	22	19
H'	2.23	2.44	2.53	2.23
E	0.74	0.83	0.82	0.76
Formicidae (Ants)				
Ant abundance	1,516	1,376	401	585
Number of species (22 total)	14	15	16	13
H'	1.26	1.24	1.68	1.57
E	0.48	0.46	0.64	0.61

*Includes all orders and classes listed in Table 2 except for Acari.

formicid CC is a good indicator for a total arthropod CC at a particular site. Ants may be ideal organisms for examining terrestrial community changes, although Alonso's (2000) review did not find them useful for this purpose. Ants make up a large portion of pitfall catches, are easy to separate from other taxa, are relatively easy to identify to the species level with a reference collection and a database such as the BDWA (Barrows & Kjar, 2004), and are inexpensive to preserve.

Sites A and J had lower abundances of isopods, orthopterans, spiders, and springtails, but nearly three times more ants than sites P and S combined (Table 2). Predaceous generalist and specialist ants may be reducing the abundance of some of these groups. For example, 32 of the 37 individuals of *Pyramica* ants, which prey upon springtails, were in sites A and J, and may have caused the low springtail abundances in these sites. Sites A and J had lower evenness among ants species compared with the other two sites. Site A had the lowest ant diversity (15 species), and 10 of these species each comprised less than 1% of the site's total ant abundance; 78% of the ants were *A. rudis* and *P. imparis* (Table 3).

All sites had very different and diverse spider assemblages, and most spider species did not show any trend in relation to the plant CCs (Tables 4 and 6). There were significantly fewer *N. agilis* (Hahniidae) in sites A and J than in the other two sites (Table 4). Heterogeneity of ground cover may have influenced the distribution of these spiders among these sites (Uetz, 1979). Sites P and S both have dense, low vegetation, while sites A and J do not. Low ground cover can affect diversity and abundance of ground-hunting spider species, and this may explain the much lower abundance of spiders caught in sites with little or no ground cover (Uetz, 1976).

Table 6. Community Coefficient of Similarity (CC) among four study sites in Dyke Marsh Wildlife Preserve, Virginia.

	Site comparison					
Taxa	**S x J**	**S x A**	**S x P**	**J x A**	**J x P**	**A x P**
Plants	0.740	0.626	0.410	0.640	0.265	0.360
Ants	0.757	0.859	0.596	0.744	0.697	0.589
Spiders	0.557	0.649	0.520	0.593	0.660	0.441
Higher taxa†	0.862	0.861	0.888	0.775	0.937	0.567
Rank combined‡	2	1	5	3	4	6
Rank ants	2	1	5	3	4	6
Rank combined without ants	1	2	5	3	4	6

† Higher taxa refers to all groups in Table 2.
‡ Ranks combined is a ranked average of data from all plants and ant, spider, and higher arthropod taxa. This scale is from 1-6, with 1 indicating the two sites most similar and 6 the two sites that are least similar.

Arthropod and plant diversities varied greatly among our study sites, and these animals and plants are likely to influence one another's diversities. Previous studies have demonstrated that insect abundance and diversity can be affected by changes in plant species abundance and diversity. An extensive study in Minnesota found that changes in plant species richness and plant functional-group diversity affect arthropod abundance (Haddad et al., 2001) as well as the stability of natural systems (Tilman et al., 1997). The proportion of native plants in a prairie reserve near Chicago, Illinois, explained nearly half of the variance in species richness of insects found in the reserve but absent from neighboring non-reserve areas (Panzer & Schwartz, 1998). A New Zealand study found that the percentage of native beetle species was positively correlated with the proportion of native plants in study sites (Crisp et al., 1998). Plant community changes, such as artificial monocultures in tropical agroecosystems, cause large changes in arthropod biodiversity and abundance (Perfecto & Snelling, 1995). Alien invasive plants can form monocultures, or near-monocultures, which are likely to change original arthropod communities. Such plants are major weeds in nature preserves, for example, Rock Creek Park in Washington, D.C. (Salmons, 2000).

In conclusion, we found 255 species and morphospecies of arthropods in a low forest that is highly invaded by alien plants. The abundance of 10 arthropod taxa varied significantly among four study sites. Future studies should examine possible relationships between arthropod biodiversity and invasive alien plants. On one hand, these plants may increase population sizes of native arthropods that feed on their nectar, pollen, and other parts. In the DMWP, many native bee, butterfly, fly, and wasp species obtain food from flowers of alien plants (pers. obs.), and some of these animals might have become more common due to these plants. On the other hand, alien plants can decrease population sizes of native arthropods. These plants can invade and change natural habitats and reduce population sizes of native plants used as food by native arthropods, and in turn reduce the numbers of these animals. Alien plants such as *Alliaria petiolata* (Garlic Mustard), *A. brevipedunculata, C. orbiculatus, Hedera helix* (English Ivy), and *L. japonica* reduce the number of native plants used as food by native arthropods.

Among the 41 plant species in this study, three aliens, *A. brevipedunculata, C. orbiculatus*, and *L. japonica* had a mean total plant cover in the four study sites of 58%. Some of the variability of the arthropods in this study may result from changes in the plant community induced by alien plants. We are currently

working on a new large-scale study with 60 replicate sites in the DMWP to test several hypotheses: Changes in terrestrial arthropod diversity are associated with the level of invasion by alien invasive plants; there are indicator groups of the diversity of the terrestrial and soil arthropod community; and native plant species richness is inversely related to level of alien plant invasion. To protect biodiversity, resource managers must know many things about native and alien arthropod species, including their identities, relative abundances, microhabitats, and other resource uses, as well as how alien, invasive organisms affect them.

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Appendix 1. Arthropod taxa from pitfall-trap samples from the low forest of Dyke Marsh Wildlife Preserve, Virginia, 2000–2001. Figures in parentheses denote the number of morphospecies that were not identified beyond the taxonomic level indicated.

- Arachnida
  - Acari (13)
    - Ixodidae (1)
  - Araneae (see Table 4)
  - Pseudoscorpiones (2)
  - Opiliones
    - Phalangiidae
      - *Hadrobunus maculosus*
      - *Leiobunum* sp.

- Chilopoda
  - Geophilomorpha
    - Dignathodontidae
      - *Strigamia bothriopa*
      - *Strigamia branneri*
    - Geophilidae
      - *Arctogeophilis umbraticus*
      - *Geophilus varians*
      - *Pachymerium ferrugineum*
  - Lithobiomorpha
    - Lithobiidae (2)
      - *Goribius* sp.
      - *Sigibius* sp.

- Crustacea (Malacostraca)
  - Isopoda (2)

- Diplopoda
  - Julida
    - Julidae
      - *Ophyiulus pilosus*
    - Parajulidae
      - *Ptyoiulus impressus*
  - Chordeumatida
    - Cleidugenidae
      - *Cleidogona* sp.

- Entognatha
  - Collembola
    - Dicyrtomidae
      - *Dicyrtoma fusca*
    - Entomobryidae
      - *Homidia sauteri*
      - *Homidia socia*
      - *Lepidocyrtus* sp.
    - Poduridae
      - *Friesea* sp.
    - Sminthuridae
      - *Symphypleona* sp.
    - Tomoceridae (1)
  - Diplura
    - Campodeidae (1)

Appendix 1 (continued)

Insecta
- Coleoptera
  - Anthicidae
  - *Tomoderus constrictus*
  - Anthribidae (1)
  - Biphyllidae (1)
  - Carabidae
    - *Platynus decentis*
    - *Harpalus* sp.
    - *Cyclotrachelus sodalis*
  - *Peocilus lucublandus*
    - *Chlaenius erythropus*
    - *Galerita bicolor*
    - *Polyderis* sp.
  - Chrysomelidae
    - *Multipunctata bigsbyana*
  - Colydiidae
  - *Paha laticollis*
  - Cryptophagidae (1)
  - Curculionidae (
    - *Ostiorhynchus rugostriatus*
    - *Callirhopallus bifasciatus*
    - *Acalles carinatus*
    - *Acalles porosus*
    - *Oedophrys hilleri*
  - Elateridae (1)
  - Endomychidae (1)
  - Histeridae (1)
  - Lampyridae
    - *Photinus* sp.
    - *Photuris* sp.
  - Leiodidae (3)
  - Nitidulidae
    - *Epuraea rufa*
    - *Stelidota geminata*
  - Pselaphidae
    - *Adranes lecontei*
    - *Brachygluta* sp.
  - Scarabaeidae (1)
    - *Anomola marginata*
    - *Onthophagus hecate*
    - *Serica brunnea*
  - Scolytidae (3)
  - Silphidae (2)
  - Silvanidae (1)
  - Staphylinidae (10)
- Dermaptera
  - Forficulidae
    - *Forficula auricularia*
- Dictyoptera
  - Blatellidae
    - *Parcoblatta* sp.
- Diptera (25)
- Heteroptera (3)
  - Lygaeidae
    - *Drymus crassus*
    - *Ozophora picturata*
  - Pentatomidae
    - *Amaurochrous cinctipes*
    - *Brochymena quadripustulata*
  - Reduviidae (1)
  - Miridae
    - *Fulvius slateri*
- Homoptera
  - Pseudococcidae (1)
  - Aphididae (1)
  - Cicadellidae (5)
  - Flattidae (1)
  - Psyllidae (1)
- Hymenoptera
  - Bethylidae (8)
  - Braconidae (1)
  - Diapriidae
    - *Basalys* spp. (2)
    - *Belyta* sp.
    - *Coptera* sp.
    - *Trichopria* spp. (4)
  - Formicidae (see Table 3)
  - Mymaridae (3)
  - Pteromalidae
    - *Alotera* sp.
    - *Dipara* spp. (2)
  - Scelionidae (18)
  - unknown micro-wasp family (3)
- Isoptera
  - Rhinotermitidae
    - *Reticulitermes flavipes*
- Lepidoptera (6)
- Mecoptera
  - Meropeidae
    - *Merope tuber*
- Neuroptera
  - Coniopterygidae (1)
- Orthoptera (3)
  - Gryllidae
    - *Hapithus agitator*
    - *Neonemobius palustris*
    - *Pictonemobius ambitosus*
  - Raphidophoridae
    - *Tachycines asynamorus*
- Psocoptera
  - Lepidopsocidae (1)
  - Liposcelidae
    - *Liposcelis* sp.
  - Polypsocidae (1)
  - Psyllipsocidae (1)
- Mycrocoryphia
  - Machilidae (1)
- Thysanoptera (2)
  - Aelopthripidae (2)
  - Thripidae (1)
- Trichoptera (1)

Symphyla (1)

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Records of Butterflies and Skippers from the Southeastern Piedmont of Virginia

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ABSTRACT

Little information is available on the butterflies and skippers from the southeastern Piedmont of Virginia. Records of butterfly and skipper species, kept incidental to field surveys for rare, threatened, and endangered animals on Fort Pickett – Maneuver Training Center, are presented. Fifty-one species of butterflies and skippers were identified on FP-MTC. Of these, 45 species were documented as new county records in at least one county. A total of 81 new county records are reported.

Key words: butterfly, inventory, Lepidoptera, military base, skipper

INTRODUCTION

A total of 168 species of butterflies and skippers (superfamilies Papilionoidea and Hesperioidea, respectively) have been documented in Virginia (Clark & Clark, 1951; Covell, 1967; Opler et al., 1995; Pavulaan, 1997; Roble et al., 2001). Very little information is available on the butterflies and skippers from the southeastern Piedmont of Virginia. Specifically, Nottoway, Dinwiddie, and Brunswick counties are all under-represented in documentation of even common butterflies and skippers (Opler et al., 1995). For example, the monarch (*Danaus plexippus*), one of the most-recognized lepidopterans, has not been reported from these three counties although they are well within its range and ample habitat is available. This paper documents butterflies and skippers observed in these three counties by zoological staff of the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH), in the course of working on Fort Pickett – Maneuver Training Center (FP-MTC) during 1993, 1999, and 2000.

FP-MTC is located in the southeastern portion of the Piedmont physiographic region (Fenneman, 1938)primarily within Nottoway, Dinwiddie, and Brunswick counties, Virginia (a small portion lies within Lunenburg County) (Fig. 1). The area is predominantly rural in character with land-use and industry being largely forestry-related (Johnson, 1991; Thompson, 1991). The climate is classified as humid subtropical with hot humid summers and mild winters (Woodward & Hoffman, 1991). The topography is characterized by rolling plains dissected and drained by the Nottoway River and its tributaries. The Fall Line, marking the boundary between the hard, resistant bedrock of the Piedmont and the softer sedimentary deposits of the Coastal Plain, lies approximately 29 km (18 mi) east of the base. Elevation ranges from 58 to 137 m (190-450 ft) above sea level (Fleming & Van Alstine, 1994).

FP-MTC covers approximately 18,251 ha (45,100 acres), a large part of which is undeveloped to provide a natural landscape for military training activities. These same areas are used for forestry and wildlife management. About one quarter of FP-MTC is designated as a 'controlled access area' (CAA), and contains firing ranges and target sites for artillery and

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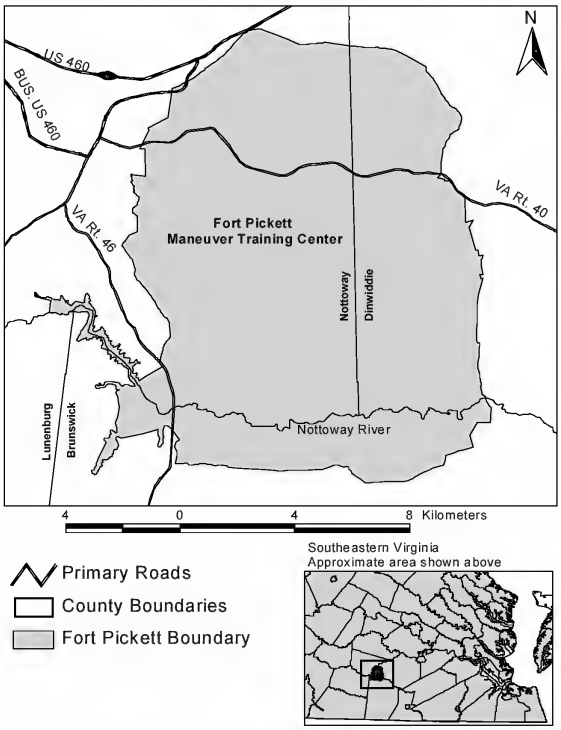

Fig. 1. Location and boundaries of Fort Pickett-Maneuver Training Center.

small arms training. This results in frequent fires, and the presence of unexploded ordnance has constrained development and forestry practices in this area.

In 1993, 1999, and 2000, FP-MTC contracted with DCR-DNH to conduct surveys for rare and endangered species. In the course of this fieldwork, lists of butterflies and skippers observed were often kept.It was not the intent of these surveys to develop a comprehensive species list for lepidopteran species occurring on the base. Thus, the list reported here is not necessarily a complete species list for FP-MTC but reports observations recorded incidental to field surveys.

Surveys were conducted in a variety of habitats including fire-maintained pine savannah, old fields, bottomland hardwood forest, upland pine/oak forests, riversides, ponds, and beaver meadows. Not all habitats were equally surveyed. For example, access to the fire-maintained pine savannah was limited to only 3-4 mid-summer surveys each year due to on-going training on the base. Observations may also reflect roadside and residential area sightings. Some specimens were collected; however, most records are based on visual identification. Collected specimens are located in the DCR-DNH collection.

Records of butterfly species were gathered from field notes taken by each zoologist. If exact locations were known, the county in which the observation took place was indicated. Observations where the location was vague or uncertain were not included in the data.

Fifty-one species of butterflies and skippers were identified on FP-MTC (Table 1). Of these, 45 species were observed in at least one new county compared to data presented by Opler et al. (1995). A total of 81 new county records were documented. None of the species is considered rare or endangered by DCR-DNH (Roble, 2003).

By way of comparison, Clark & Trainer (1941) documented 73 species of butterflies and skippers during surveys for Lepidoptera from adjacent Prince Edward County. Opler et al. (1995) listed 75 species from this county. In 1998 and 1999, a survey of butterflies and skippers was conducted by DCR-DNH on Marine Corps Base, Quantico in the northeastern Piedmont of Virginia. Sixty-one species were documented from habitats similar to those at FP-MTC (Chazal, 2000). It is likely that the number of butterfly and skipper species present on FP-MTC is higher than reported here and that further, more concentrated efforts would expand the list.

The diversity, complex life cycles, and numbers of Lepidoptera make them an important component of ecological systems as pollinators, prey, and primary consumers. Butterflies and skippers are relatively well-studied groups of insects because of their accessibility and their aesthetic appeal; however, they are often overlooked as an important part of natural resource management. The first step to including them in the conservation process is to identify the species present and the habitats with which they are associated. The records presented here should help to fill information gaps in our understanding of the distribution of butterflies and skippers in Virginia.

ACKNOWLEDGMENTS

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Table 1. Butterfly and skipper species observed by DCR-DNH in 1993, 1999, and 2000 on FP-MTC. The county in which the observation occurred is given. An 'X' indicates visual observation only, a 'C' indicates a specimen from FP-MTC is in the DCR-DNH collection, an 'O' indicates the species is reported from that county by Opler et al. (1995), and a 'P' indicates a photograph was taken by S. M. Roble. Common names follow Opler et al. (1995).

Family	Species	Common name	Brunswick	Dinwiddie	Nottoway
Papilionidae	*Battus philenor*	Pipevine swallowtail			X, O
	Eurytides marcellus	Zebra swallowtail	X	X	X, O
	Papilio glaucus	Eastern tiger swallowtail	X	X	X, O
	Papilio polyxenes	Black swallowtail		X	X
	Papilio troilus	Spicebush swallowtail	X	X	X
Pieridae	*Anthocharis midea*	Falcate orangetip	X		O
	Colias eurytheme	Orange sulphur	X, O	X, O	X, O
	Eurema lisa	Little yellow		X	
	Eurema nicippe	Sleepy orange	X		
	Phoebis sennae	Cloudless sulphur	X	X	X, O
	Pieris rapae	Cabbage white	X, O		X, O
Lycaenidae	*Callophrys gryneus*	Juniper hairstreak	X		O
	Calycopis cecrops	Red-banded hairstreak	X		X
	Celastrina ladon	Spring azure	X		
	Celastrina neglecta	Summer azure	C	X	X
	Everes comyntas	Eastern tailed-blue	X	C	X, O
	Feniseca tarquinius	Harvester	C		
Nymphalidae	*Asterocampa celtis*	Hackberry emperor	C		
	Asterocampa clyton	Tawny emperor	X	X, O	
	Cercyonis pegala	Common wood nymph		X, O	X
	Chlosyne nycteis	Silvery checkerspot	C		
	Cyllopsis gemma	Gemmed satyr			C
	Danaus plexippus	Monarch	X	X	X
	Euptoieta claudia	Variegated fritillary	X	C	X
	Hermeuptychia sosybius	Carolina satyr	C	C, O	C, O
	Junonia coenia	Buckeye	X	X	X
	Libytheana carinenta	American snout		X	X
	Limenitis archippus	Viceroy		X	X
	Limenitis arthemis astyanax	Red-spotted purple			P
	Megisto cymela	Little wood satyr	X	X, O	X
	Phyciodes tharos	Pearl crescent	X	C	C, O
	Polygonia comma	Eastern comma			X
	Polygonia interrogationis	Question mark			X
	Satyrodes appalachia	Appalachian brown	X	C, O	X
	Speyeria cybele	Great spangled fritillary	X	X	X
	Vanessa atalanta	Red admiral		X, O	O
	Vanessa cardui	Painted lady			X
	Vanessa virginiensis	American lady	X	X	X
Hesperiidae	*Achalarus lyciades*	Hoary edge		X	C
	Ancyloxypha numitor	Least skipper	X	X	X
	Atalopedes campestris	Sachem		X	X
	Epargyreus clarus	Silver-spotted skipper	X	C	X
	Erynnis baptisiae	Wild indigo duskywing			C
	Erynnis horatius	Horace's duskywing		C, O	O
	Erynnis juvenalis	Juvenal's duskywing	X		O
	Euphyes dion	Dion skipper		C	
	Nastra lherminier	Swarthy skipper	O	O, X	
	Poanes zabulon	Zabulon skipper	C	X	X
	Polites themistocles	Tawny-edged skipper	O	X	
	Pompeius verna	Little glassywing	X	X	
	Thorybes bathyllus	Southern cloudywing	X	C	C

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Notes on an Autumn Roost of an Eastern Small-footed Bat (*Myotis leibii*)

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ABSTRACT

Myotis leibii is a rarely encountered bat, with most records obtained during hibernation. A specimen was found in late September roosting in a rock crevice on a forested hillside along the Virginia-West Virginia border.

Key words: bat, Chiroptera, *Myotis leibii,* roosting behavior.

The eastern small-footed bat (*Myotis leibii*) is the smallest bat in the eastern United States, weighing as little as 3-4 g (Harvey, 1992). The species ranges from eastern Canada and New England south to Georgia and west to Oklahoma, and is considered relatively rare throughout its range (Harvey, 1992). Choate et al. (1994) stated that it is "considered one of the rarest species of bats in the eastern United States." It was formerly regarded as a candidate for listing as a federally endangered or threatened species (U.S. Fish and Wildlife Service, 1994).

Myotis leibii was first reported from Virginia by Johnson (1950), who cited records for two caves in Bath and Highland counties. Relatively few additional records were added during the subsequent half-century. Handley (1979, 1991) reported that *M. leibii* is uncommon in Virginia, but does not warrant threatened or endangered status in the state. The range map in Linzey (1998) suggests that the species is widespread in western Virginia, but there are confirmed records from only 13 counties, ranging from Augusta, Bath, and Highland in the north to Dickenson, Wise, Scott, and Lee in the south (Hobson, 1998; Virginia Department of Game and Inland Fisheries, 2002). There are 24 current or historical sites for *M. leibii* in the Division of Natural Heritage database. The species was collected twice in 1907 on Plummer's Island, Montgomery County, Maryland (Bailey, 1946), but it has not been recorded from the Virginia shoreline of the Potomac River (Hobson, 2001). Feldhamer et al. (1984) plotted five locality records for *M. leibii* in western Maryland (where the species is listed as state threatened), but only a handful of individuals were found during cave surveys in the region (Gates et al., 1984). *Myotis leibii* has been recorded from nine counties in eastern West Virginia, four of which border Virginia (West Virginia Department of Natural Resources, 1987). Stihler (2000, 2003) reported that only a few West Virginia caves harbor more than five *M. leibii* during winter and noted that "limited research" revealed the species roosts in rock outcrops in summer. Despite records of *M. leibii* in northeastern West Virginia and western Maryland, there are no confirmed records of this species from northwestern Virginia (i.e., north of Augusta and Highland counties).

Most Virginia records of *M. leibii* have been obtained in caves or near cave entrances (Handley, 1979; Dalton, 1987; Hobson, 1998). Dalton (1987) found *M. leibii* in only 16 of 106 (15%) Virginia caves inhabited by bats. The species was recorded in caves in 10 counties, but represented <1% of the total number of bats observed during her surveys. Hobson (1998) obtained 11 summer records of *M. leibii* at five sites in far southwestern Virginia during mist net sampling.

Throughout the range of *M. leibii* most records are of hibernating individuals with only a few summer observations reported (Hitchcock, 1955; Barbour & Davis, 1969; Hall, 1985). The species is usually solitary and commonly roosts in cracks, fissures, and crevices, sometimes beneath rocks on cave floors or on the ground (Davis, 1955; Krutzsch, 1966; Barbour & Davis, 1969, 1974; Choate et al., 1994). Barbour & Davis (1974) found *M. leibii* under rocks on a hillside as well as in a quarry. The species has also been found

in hollow trees, buildings, and expansion joints beneath highway bridges (Hitchcock, 1955; Barbour & Davis, 1974; Harvey, 1992). Webster et al. (1985) stated that the habitats occupied by *M. leibii* in the Appalachian Mountains are poorly known, but that "roosts usually are found in hemlock forests."

At approximately 1145 h on 26 September 2002, I found a *M. leibii* (presumably an adult) in a small, hillside boulder field (Fig. 1) in the Bother Knob area of Shenandoah Mountain along the Virginia-West Virginia border (George Washington National Forest). The bat was resting (possibly sleeping) in the crevice-like space between two large rocks (Fig. 2). The upper rock had a maximum dimension of approximately 40 cm (16 in) and was about 5 cm (2 in) thick. The bat was in a huddled, horizontal position on the topside of the lower rock (Fig. 3). Upon disturbance, it began crawling and attempted to fly weakly before entering a nearby rock crevice. Air temperature was approximately 15 ºC (59 ºF), skies were mostly overcast, and light rain was falling. The forest was dominated by northern hardwoods and the canopy above the site was partially open.

Fig. 1. Boulder field where diurnally-roosting specimen of *Myotis leibii* was found on Bother Knob, Shenandoah Mountain. The bat was located beneath the rock indicated by the arrow.

Fig. 2. Lateral view of rock crevice inhabited by *Myotis leibii*. The bat occupied the space between the upper and lower rocks.

Fig. 3. Dorsolateral view of resting *Myotis leibii* immediately after removal of the cover rock.

My observations were made at an elevation of approximately 1300 m (4260 ft) on the southwest-facing slope of Bother Knob in Pendleton County, West Virginia, within 100 m of the Virginia (Rockingham County) state line. Bother Knob is ca. 20 km (12.5 mi) north and 40 km (25 mi) northeast of the nearest documented sites for *M. leibii* in Augusta and Highland counties, respectively. Stihler (2001) reported this species from 11 caves in Pendleton County (≤ 4 *M. leibii* per cave). Additional surveys in the vicinity of Bother Knob, using a variety of sampling methods including mist nets, as well as elsewhere along Shenandoah Mountain (including nearby Reddish Knob), are warranted to learn more about the status and distribution of this poorly-known species. Surveys at or near boulder fields throughout western Virginia may support the assumption that *M. leibii* is more common in the state than is currently documented.

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Chris Hobson and Craig Stihler confirmed my identification on the basis of several photographs. Chris also made a copy of his unpublished thesis available to me and Craig provided several references. Terry Slater of the Dry River Ranger District, George Washington National Forest, provided directions to Bother Knob.

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Early Fall Coyote Foods in Campbell and Bath Counties, Virginia

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ABSTRACT

The diet of coyotes (*Canis latrans*) was studied on two sites in Virginia from September to October 2002. Plant material, particularly persimmon (*Diospyros virginiana*), was found in the majority of scats examined, which supports the model of coyotes as opportunistic omnivores. Given the adaptive nature of coyotes, longer-term studies are needed to fully understand their impact on the biota as their range expansion continues.

Key words: *Canis latrans,* coyote, scat analysis, Virginia.

INTRODUCTION

Many researchers have investigated coyote (*Canis latrans*) diet (e.g., Fichter et al., 1955; Bowyer et al., 1983; Rose & Polis, 1998). It is clear from the results of these studies that coyotes are opportunistic omnivores that consume a large variety of foods and that their diets vary at several scales, including seasonally (Bowyer et al., 1983; Andelt et al., 1987), spatially (Rose & Polis, 1998), and individually (Fichter et al., 1955). Because of this variability, it is often impossible to predict what the diet of coyotes will be in any given area with any more precision than to say that it will probably consist of a variety of small to medium-sized mammals, supplemented by birds, insects, and vegetation.

The adaptability of coyotes continues to fascinate researchers and frustrate landowners. In the western United States, people have largely learned to coexist with coyotes (although not always peacefully). In the East, however, coyotes are a relatively new phenomenon and many people are unsure how to deal with them. As they continue their range expansion, there will be a growing need for sound information on their ecology so that effective management decisions can be made. Coyotes may compete for resources and directly affect populations of prey species or indirectly affect plant species through seed dispersal.

It is important to assess the role of coyotes as they enter new habitats (Toweill & Anthony, 1988). Chamberlain et al. (2000) noted that most studies of coyote diet have been conducted in the western and northern parts of their range. Given the adaptability of these animals, data from these studies are probably of limited value to understanding the ecology of coyotes in the East. The purpose of this investigation was to determine the major food items in the diet of coyotes in one area of the eastern part of their range during the early fall. A secondary objective was to document if coyotes were preying on cattle, which are raised in the study area. Since coyotes are known to prey on other domestic livestock, such as sheep (Shivik et al., 1996; Sacks et al., 1999), there is the possibility that coyotes may prey on cattle as well.

METHODS

I collected and analyzed the composition of 17 coyote scats from two study sites during September and October of 2002. The majority of scats (n=14) were collected from a 60.7 ha farm in Campbell County, Virginia that is used primarily for grazing cattle. It consists of four fields, averaging 8.1 ha each, which are maintained for grazing and haying and are predominantly characterized by fescue and orchard grass. Juxtaposed with the fields is a matrix of forest of

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varying stand types and ages, including 10-15-year-old planted pines and 60-70-year-old mixed hardwoods. A first order stream, originating on the property, bisects much of the land. The farm has gently rolling hills without any steep slopes and a maximum elevation of 275 m. It is surrounded by properties with similar characteristics.

For comparison, three samples were collected from a site on Back Creek Mountain, located in the George Washington National Forest in Bath County, Virginia. This area is mostly 60-70-year-old mixed hardwood forest, although a few small 10-year-old clearcuts are present. There are no lotic water sources on the mountain, but there are a few water holes that have been created by the Forest Service. The terrain is generally steep with a maximum elevation of about 732 m (2400 ft).

Coyote feces were distinguished from sympatric canids (foxes, wild dogs) by shape, smell, size (Murie, 1974), and the presence of nearby tracks. If the identity of a scat was questionable, it was not collected. Each scat collected was placed in a plastic bag labeled with the date and location. Samples were placed on ice during transport and then frozen until analyzed.

Scats were thawed, then autoclaved for 15 minutes to destroy any endoparasites or tapeworm eggs that may have survived freezing (Litavaitis et al., 1996). Dissolvable material was separated from the major food items by placing the scats on a 1/16-inch mesh screen and washing with running water. Food items were then manually separated and identified. Mammals were identified by bones and hair, plants by seeds, and arthropods by exoskeleton fragments. Several guides were consulted to assist in species identification (Brown, 1952; Mayer, 1952 for mammals; Harlow, 1946 for plants; Borror & White, 1970 for arthropods). However, identification below the level of major taxonomic groups proved difficult. Much of the fecal contents was unidentifiable, which is not an unusual occurrence in these types of investigations (Putman, 1984). Food items were recorded by frequency of occurrence (number of scats with item /total number of scats).

RESULTS

The majority of scats (53%) contained both plant and animal material. Twenty-nine percent contained only animal material and 18% contained only plant material. Because of the small sample size, a statistical analysis could not be used to test for differences between scats collected in the forested site and the farm site. Therefore, all scats were combined for this analysis.

Plant, arthropod, and mammal remains were recovered from the scats. Five species of plants (only persimmon was positively identified), one arthropod species (grasshopper), and at least one mammalian species were found. It is likely that more than 7 species were consumed (i.e., probably several mammalian species were consumed), but because of the difficulties encountered with identifying both plant and animal remains, a more thorough account of the scat contents could not be made. Plants occurred in 71% of the scats (with persimmon occurring in all scats with plant material), arthropods (grasshoppers) in 18%, and mammals in 76%. The four species of unidentifiable plants (known to be different species by the different seeds) combined to occur in 29% of the scats.

DISCUSSION

As expected, mammals occurred in a significant number of scats (76%) in my sample. This is similar to the results of other studies. Andelt et al. (1987) found that mammals made up to 64% of coyote diet during early fall, and others (Fitcher et al., 1955; Bowyer et al., 1983; Rose & Polis, 1998) found that mammals make up the most significant portion of coyote diet, although this is highly variable throughout the year. The significance that plants, particularly persimmon (*Diospyros virginiana*), played in the diet of coyotes was unexpected. Most studies have found that although plants may occasionally play a significant role in coyote diet, especially during late spring and early fall or when prey availability is low, nothing in the literature suggests that plants occur in excess of 71% of scats, as was found in my study. Furthermore, although no formal measure of food item proportions within individual scats was made, most of the scats containing plant material were significantly plant-based. That is, they may have contained animal material in addition to the plant material, but the bulk of the scats consisted of plant material.

The frequency of persimmon occurring in the scats was surprising. Litvaitis & Shaw (1980) found persimmon seeds in 46% of coyote scats in the fall and Cypher & Cypher (1999) reported that coyotes were significant dispersers of persimmon seeds. It is possible, especially at the Campbell County site, that the recovered scats only represent one or two individuals who rely on persimmon to a greater extent than most of the population. However, many of the scats collected from the farm in Campbell County were almost exclusively comprised of persimmon seeds and even two of the three scats collected at the forested site contained persimmon seeds. This suggests that persimmons may play a more significant role in the fall

diet of eastern coyotes than in their western counterparts.

Longer-term studies of coyote diets are needed to fully determine the range of species consumed and the possible effects that coyotes may be having in the eastern United States as their range expands. The results of my study suggest that during the early fall, coyotes rely extensively on plant matter. Seasonal variation of coyote diet has been demonstrated in many studies, and although the current investigation only covered a limited time frame, the results seem to corroborate the definition of coyotes as opportunists, whether they are in the West or the East. As opportunists, coyotes present special challenges to researchers in determining the long-term effects of their presence in the eastern United States.

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SHORTER CONTRIBUTIONS

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CALYPTOPROCTUS MARMORATUS, A STRIKING PLANTHOPPER, ARRIVES IN VIRGINIA FROM PARTS SOUTH (HOMOPTERA: FULGORIDAE)—While light-trapping for moths and other nocturnal insects in Patrick and Franklin counties, Virginia, during the 1999 and 2000 seasons, Anne C. Chazal (Department of Conservation and Recreation, Division of Natural Heritage) obtained several specimens of a large and colorful insect which upon its arrival at VMNH I initially considered to be a small species of cicada. Only when a specimen was shown to Dr. Lewis Deitz (North Carolina State University), was it identified as a native, although uncommon, fulgorid. According to information provided by Dr. Lois O'Brien (*in litt*., 2001), this species is *Calyptoproctus marmoratus,* named by the Marquis Massimiliano Spinola in 1839 from material with no closer locality data than "Amerique septentrionale."

Spinola's species, succintly described, fell into obscurity as its type material remained in his private collection for decades and only recently became available for study, following its transfer to the Naturhistorisches Museum, Vienna. Apparently *C. marmoratus* has not figured in the literature on American insects, even though it is represented in a number of collections under the name *Alphina glauca*, proposed by Zeno Payne Metcalf in 1923 for specimens from southwestern United States. General references such as Arnett's *American Insects* (1993: 213) do not mention *Calyptoproctus* in any context. It is anticipated that the taxonomy and nomenclature of this species will be formally clarified by Dr. O'Brien as a result of her examination of Spinola's type specimen. That such a large (nearly 20 mm long) and colorful Virginia homopteran was not registered for the North Carolina fauna (Brimley, 1938; Wray, 1967), inspired an interest in details of its distribution, particularly since Metcalf himself had collected fulgorids in that state for years without encountering this one. I thereupon surveyed various insect collections in southeastern United States in the hope of locating some unpublished records. The results have been interesting: a considerable number of specimens were found, and their provenance and dates of capture recorded on a large scale map (Fig. 1). Apparently *C. marmoratus* is actually widespread in the region between central Virginia and the Florida panhandle, but the earliest recorded collection date that I found is 1962, for Florence, South Carolina; others are dispersed from 1963 onward, the most recent being four sites in Virginia in 1999, 2000, and 2001.

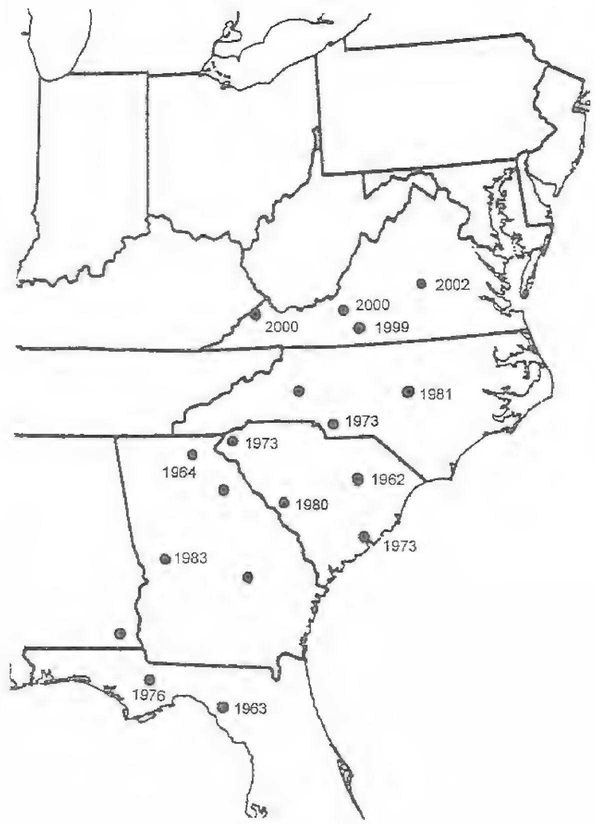

Fig. 1. Southeastern United States, with collection sites for *Calyptoproctus marmoratus*. Undated dots north of Florida are from years later than the earliest shown in each state, or from specimens without year of collection indicated. Occurrence of the species in Tennessee and Kentucky may be assumed with some confidence.

How can this situation be explained? It is certainly not attributable to lack of collecting. In Virginia, at least, trapping with blacklight has been conducted at scores of locations statewide for the past decade (by VMNH and DCR-DNH surveys) and less intensively for the two previous decades by survey personnel of the Cooperative Extension Service, VPI&SU, as well as myself. Comparable efforts also have been made in other southern states. That specimens have mostly appeared in collections since about 1980 suggests that recent migration into the region has taken place. One must suspect a rare native species experiencing a dramatic population increase in the mid-1960s followed by northward dispersal, perhaps in response to recent climatic warming in southeastern United States (cf. account of northward spread by the lygaeid bug *Neopamera albocincta* in Hoffman, 1996). It will be of

much interest to document the additional collections likely to be made in this state. If the apparent rate of movement is maintained it is not inconceivable that *Calyptoproctus* could arrive in Maryland or Pennsylvania by 2005 (if in fact it is not already there).

Virginia records (all VMNH) are as follows: *Appomattox Co.*: Holiday Lake State Park, 9 June 2002, Robert Vigneault (1). *Dickenson Co.*: Breaks Interstate Park, 1-14 July 2000, Robert Vigneault (2). *Patrick Co.*: near end of Rte. 624, head of Philpott Lake, 25 May 2000 (1); 13 August 1999 (1), both Anne C. Chazal. *Roanoke Co.*: Vinton, 26 May 2000, M. W. Donahue (1). Capture of *C. marmoratus* at the Breaks park, on the Kentucky state line, implies that the species is now present and awaiting discovery, in that state and Tennessee.

A fairly extended period of activity (late May-early August) is thus documented. All but one of the specimens cited were taken at UV light. So far, despite the extensive range occupied by the species, the host plant preferred by *C. marmoratus* remains to be discovered, another challenge to students of these insects.

Calyptoproctus marmoratus is easily recognized by the combination of its large size (15-20 mm) and color pattern: the forewings have an orange marginal spot at the base, followed immediately by a larger marginal black spot; distal parts of the wings are pale green, irregularly marked by small black flecks; the veins are generally black, enclosing clear cells (Figs. 2, 3). As noted, the general body form somewhat resembles that of a small cicada.

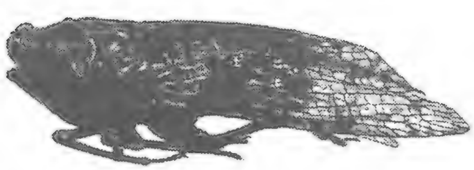

Fig. 2. *Calyptoproctus marmoratus* Spinola, lateral aspect of specimen from Patrick Co., Virginia. Total length to tips of wings, 18 mm.

Fig. 3. The same specimen, dorsal aspect to show outline of head and elytral pattern.

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OCCURRENCE OF INTRADERMAL MITE, *HANNEMANIA* SP. (ACARINA: TROMBICULIDAE), PARASITES IN TWO SPECIES OF AMPHIBIANS IN VIRGINIA—Chiggers, or trombiculid mites, are ectoparasites of a wide array of vertebrates, including amphibians and reptiles. Common ectoparasites apparently restricted to frogs and salamanders are species of the trombiculid mite genus *Hannemania* (Loomis, 1956). Host integument tissue is invaded by the larvae of this genus where they insert their mouthparts into the skin and form small red pustules that are visible to the naked eye. Reported amphibian hosts include species in the frog genera *Bufo*, *Gastrophryne*, *Hyla*, *Pseudacris*, *Rana*, and *Scaphiopus* and the salamander genera *Ambystoma*, *Desmognathus*, *Eurycea*, and *Plethodon* (Regester, 2001). *Hannemania* parasites have been reported from *Rana catesbeiana*, *R. clamitans*, *R. palustris*, and *R. sphenocephala* from North Carolina (Brandt, 1936; Murphy, 1965). Rankin (1937) reported chiggers on *Ambystoma maculatum*, *A. opacum*, *Eurycea guttolineata*, and *Plethodon glutinosus* from North Carolina. The only report of chiggers on amphibians from Virginia is by Loomis (1956), who reported *Rana clamitans* and *R. palustris* as hosts. This paper reports recent observations of *Hannemania* sp. parasitism on one salamander species and a frog from two locations in Virginia.

A juvenile (47 mm SVL) *Rana palustris* (pickerel frog) with chiggers was found in a spring box on 4 October 2003 at the Chancellorsville Battlefield, 12.6 km W Fredericksburg, in the Fredericksburg/ Spotsylvania National Military Park, Spotsylvania County, Virginia by Will Brown and Lenny Leta. Dissection of one red pustule revealed a larval chigger inside. In total, 13 chiggers occurred on the inside of the right thigh, eight in the inside of the left thigh, and four on the rear thigh near the cloaca. Two other juvenile *R. palustris* were captured, as well as a juvenile *Rana clamitans* and three *Pseudotriton ruber* larvae. None of these specimens had chiggers. Amphibian specimens were donated to the National Park Service (Shenandoah National Park, Herpetological Collection). Murphy (1965) reported a prevalence of 78% in a sample of 201 *R. palustris* from North Carolina. McAllister et al. (1995) reported chigger mites on pickerel frogs from Arkansas. Loomis (1956) had previously reported *Hannemania dunni* larvae in this frog from Virginia but did not note a specific locality. The occurrence of this parasite in Spotsylvania County forms the second report of chigger mites on *Rana palustris* from Virginia.

On 15 August 2002 and 10 September 2003, C. Todd Georgel found single individuals of *Eurycea cirrigera* (southern two-lined salamander) with red pustules identical to those observed in the *Rana palustris* likely containing *Hannemania* sp. in Fort Lee, Prince George County, Virginia. The former was a juvenile (29 mm SVL, 32 mm tail length) caught under a rock in a tributary leading to Bailey's Creek with at least nine red pustules. They were located as follows: one on the right neck, one on the right lateral side behind the right forelimb, one on the left upper arm, one just anterior to the right rear limb insertion, two above the right limb insertion, two on the right foot, and one on the distal third of the tail. On the latter date he caught a male salamander (37 mm SVL, 42 mm tail length) under a log in the Bailey's Creek watershed in mixed hardwood forest with a total of eight chigger mites. These occurred as follows: one on each forearm, one 1 mm anterior of the left forearm on the neck, one on the posterior surface of the right thigh, one inside the right thigh, two near the right knee, one on the left forefoot, and one on the base of the tail 3 mm posterior to the right rear leg. Both specimens were released. *Hannemania* parasitism has only been reported previously for *E. cirrigera* in Tennessee by Regester (2001). He found a prevalence of 48.7% infestation (1-24 per individual) in a sample of 158 salamanders. The Virginia observations expand the known geographic range of chigger mite parasitism in the Southern Two-lined Salamander.

Rankin (1937) suggested that *Hannemania* parasitism in amphibians was limited to those species that used terrestrial habitats for long periods of time. Both *Eurycea cirrigera* and *Rana palustris* occur frequently in leaf litter and under surface objects well away from water (Conant & Collins, 1998; Petranka, 1998; pers. obs.). The low occurrence of chiggers in more aquatic frogs such as *Rana catesbeiana* and *R. clamitans* suggests that they are usually not terrestrial long enough for larval mites to attach to a host, resulting in low prevalence (Murphy, 1965). It would be instructive to compare chigger mite prevalence in large samples of Virginia amphibians to test this hypothesis.

The specific identification of chigger mite parasites on amphibians is hindered by the fact that the infective life history stage is the larva (McAllister et al., 1995). Hyland (1956), Loomis (1956), and Murphy (1965), however, identified the chigger in amphibian specimens from North Carolina and Virginia as *Hannemania dunni*. Although it may be that the parasites on the two amphibians reported here represent a different species, it is also possible given the geographic proximity of the work in North Carolina and Loomis' identification in

Virginia that the parasite is *H. dunni*. It remains clear, however, that more detailed studies of chigger mite parasitism in these vertebrates in Virginia need to be undertaken.

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MISCELLANEA

Reviews

For Love of Insects by Thomas Eisner. 2003. Harvard University Press, Cambridge, MA. 448 pp. Hardcover $29.95. (www.hup.harvard.edu)

Why is a vertebrate ecologist, a herpetologist in particular, writing a review on a book about insects? This highly readable book is not only about the lives of insects, how they eat, how they defend themselves, and how they behave; it is about discovery in the world of nature. It is autobiographical in the sense that Eisner puts his many discoveries in context with his original observations and with the ways that he and his colleagues and students carried out the ingenious experiments to decipher the evolutionary benefits of the behavior, chemical, and structure in question. It is a book about combining field observations with laboratory experiments. It is a book about how science can be fun.

Thomas Eisner, a chemical ecologist, entomologist, and a recipient of the National Medal of Science, has a way with words. His prose draws you into the stories he tells. He often sets up his chapters with a personal anecdote or a piece of history. My favorite is his story about a French aeronautical engineer, Henri Coanda, who in 1910 built a proto-jet aircraft and discovered that liquids and gases have a propensity, when flowing along a curved surface, to cling to that surface and follow the curvature. This is why pouring coffee out of a pot into a cup often spills over the curved lip. It is appropriately called the Coanda effect. Coanda's wooden plane caught on fire because the curved metal plates were turned the wrong way. His chapter openings occasionally have nothing to do with insects, at least until he makes the connection later when he is explaining the function of a particular structure or chemical action. Eisner's ability to decipher the structure of defensive chemicals produced by beetles, moths, millipeds, caterpillars, and other invertebrates and describe their functional roles is legendary. Despite the chemistry involved, however, this book is easy to read. I did sometimes want to know the common name of the species he was discussing since he usually referred to them only by their scientific names.

Eisner was born in Germany in 1929 but his family left when Hitler rose to power. They moved to Paris, then to Spain until the Spanish Civil War of 1936 drove them to Uruguay. From there they moved to the United States in 1947 after he finished high school. He entered Harvard University a couple of years later, graduated in 1951, and finished his Ph.D. there in 1955. His closest friend at Harvard was E.O. Wilson, who incidentally wrote the Foreword to this book and remains a close friend. They drove across country in the summer of 1952 to explore and do field work and it made conservation biologists of them both. We are all familiar, of course, with Wilson's contributions in that arena. Eisner's real love was the chemical defenses of insects and his first series of now famous studies was on the hot (100 ºC), benzoquinone spray produced by bombardier beetles (Chapter 1). Although he has done research all over the world, Eisner has two favorite places to explore and make discoveries. One is the Archbold Biological Station in Florida and the other is American Museum of Natural History's field station in southeastern Arizona at Portal. Many of the stories he tells stem from his observations at these sites.

One of my favorite stories is about a small beetle that lives on the fronds of palmetto plants in Florida. This beetle, *Hemisphaerota cyanea*, looks kind of like a Volkswagon with its curved shell. Its larvae cover themselves with fecal strands, called thatch, that look like Medusa's head that are used for concealment. The adults have an ingenious way of holding themselves down on the frond. They use about 60,000 microscopic tarsal bristles on their tarsi and an oil they produce from pores that withstands considerable upward pressure, some 240 times their body mass. The adhesion and the muscle tension make them difficult to pry them off. In human terms, a 155-lb human could withstand a pressure of 23,000 lb. It turns out that there is a wheel bug that injects a neurotoxin that causes muscle relaxation so that it can turn the beetle over and eat it. I also liked his experiments with spider webs and how some insects are able to escape predation by orb weavers. The stabilimenta (those white zigzag lines around the center) on orb spider webs that remain up in the daytime evolved to prevent birds from flying into and destroying them. The stories go on and on and one is always amazed at the myriad of ways that invertebrates function in nature. Eisner points out in the last chapter that discovery in nature is what fuels the human intellect. We need nature as much as nature needs us.

Eisner exemplifies a trait I would like to see in more naturalists and field biologists - he writes up his results, sometimes in the field before getting back home, and publishes them. He may hold the record for the most papers in the *Proceedings of the National Academy of Sciences and Science*. Few of us could come close to this level of achievement. We all could, however, aspire to publish more of our natural history observations.

Indeed, this is the primary reason I started *Banisteria*.

Not only is the text in this book written by Eisner but he also took most of the incredible photographs, except the scanning electron micrographs that were taken by his wife. Eisner is a master photographer of insects and their structures and actions. His photographs document his discoveries of how invertebrates do what they do. He shows us that carrying the right photographic equipment in the field allows us to document all sorts of new facts and behaviors. The photographs then allow us to ask questions that lead to scientific inquiry.

This book is a must read for any and all naturalists and observers of nature, no matter what their primary interest, be they birds, reptiles, or insects. It is a good bargain for the price and worth it for the stories and photographs. Your view of the natural world around you will forever be changed.

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Amphibians and Reptiles of Delmarva by James F. White, Jr., & Amy Wendt White. 2002. Tidewater Publishers, Centreville, MD, in association with the Delaware Nature Society, Inc. 248 pp. ISBN 0-87033-543-X, paperback. $14.95. To order contact Judy Oswald, Ordering Accounting Department, Cornell Maritime Press & Tidewater Publishers, P.O. Box 456, Centreville, MD 21617. Phone: 800-638-7641; Fax: 410-758-6849; email: cornell4@crosslink.net

This book is the second in a series of natural history guides for the Delmarva Peninsula that has been produced by the Delaware Nature Society and Tidewater Publishers. The first guide treated the region's butterflies (see Roble, 1995). I recently learned that a proposed future guide in the series will concern the dragonflies and damselflies of the region.

This pocket-sized guide discusses 71 species of amphibians and reptiles that have been documented on the Delmarva Peninsula (only the timber rattlesnake is considered extirpated), plus two others (six-lined racerunner and northern pinesnake) that may inhabit this region which encompasses Delaware plus the Eastern Shore portions of Maryland and Virginia. It is the first book-length treatise on this fauna, although it should be noted that the pioneering studies of the late Roger Conant, initiated in 1939, documented at least 67 of these species (Conant, 1945, 1958). The few subsequent additions to this fauna include recognition of a second, sibling species of gray treefrog in eastern North America and introduced populations of red-eared sliders established via the release of pet trade specimens (discussed at some length in this book). Of the 71 species confirmed for the Peninsula, 47 (19 amphibians, 28 reptiles) inhabit the Eastern Shore of Virginia (Mitchell, 2002). Except for a small segment at its extreme northern end that lies within the Piedmont, the entire Delmarva Peninsula falls within the Coastal Plain physiographic province. The second page of the book contains a detailed map of the region, showing the major rivers, islands, and the physiographic boundary; a county map appears on page 35.

Brief introductory chapters cover such topics as the history of herpetology in the region (separate sections for each state), physiography and habitats, and suggestions and hints for finding, observing, and documenting amphibians and reptiles. In the latter case, no mention is made of regional organizations such as the Virginia Herpetological Society or the Virginia Natural History Society for reporting noteworthy distributional records. The bulk of the text contains the species accounts, which are followed by a brief chapter on conservation, a checklist of amphibian and reptile species in the region (exclusive of extirpated and hypothetical species), a glossary (6 pages), literature citations (19 pages), and an index (9 pages). The conservation section includes a table showing the legal status (state and federal) and natural heritage rank of species of conservation concern in one or more of the three states in the region. A noteworthy paper published at about the same time that this book appeared is Mitchell (2002). Except as noted below the reference section appears to be rather complete, and the glossary and index are quite useful.

The species accounts are concise, well-written, and usually accurate, and were prepared with beginners in mind. Each account covers a wealth of information presented under the following topics: scientific and common names (including alternate common names), reference to a color plate, description (size, coloration, etc.), similar species, overall (global) range, range (including a small map) and status on the Delmarva Peninsula, habitat, voice (frogs and toads), reproduction and development, and miscellaneous remarks. The genus name applied to several species (e.g., wood turtle, bog turtle, six-lined racerunner) already has been changed since the publication of this book. The range maps for most species consist of shaded county maps (i.e., an entire county is darkened if the species has been recorded from that county), but in some cases the range is drawn more precisely (e.g., the green treefrog [*Hyla cinerea*] and northern diamond-backed terrapin

[*Malaclemys terrapin terrapin*] both largely follow the coast and Bay shores, with the former being in inland areas and the latter inhabiting offshore waters). At the northern end of the Peninsula, where several species are limited to either the Piedmont or Coastal Plain, the maps clearly indicate which portion of the two counties in question (one each in Delaware and Maryland) each species occupies. The range map for the barking treefrog (*Hyla gratiosa*), which has a very limited distribution on the Peninsula, is perhaps the most detailed of all. No map is provided for some species such as the hellbender (no confirmed recent records) or the various sea turtles. The species accounts for the sibling species of gray treefrogs (*Hyla chrysoscelis* and *H. versicolor*) are combined, including the range map, but the text provides a brief discussion of the known differences in the ranges of these species on the Peninsula and indicates that more field surveys are needed to better define their respective ranges. The following recently published county records for the Eastern Shore of Virginia are not reflected in the range maps: Accomack County – broad-headed skink (*Eumeces laticeps*) (Mitchell & Conant, 2000); eastern gartersnake (*Thamnophis sirtalis sirtalis*) (Hobson & Stevenson, 1995); Northampton County – marbled salamander (*Ambystoma opacum*) (Roble et al., 2000); ring-necked snake (*Diadophis punctatus*) (Roble, 2001). The range map for the northern two-lined salamander (*Eurycea bislineata*) indicates that it is known from Northampton County, whereas Mitchell (2002) reported that it is unknown from this county but he may have observed one individual (which escaped capture) along a stream in Accomack County, the only known potential sighting for the Eastern Shore of Virginia.

The middle of the book contains 32 color plates, each displaying three photographs (all ca. 4.5 x 8 cm, including 12 habitats and 84 live specimens). All species treated in the book are represented by at least one photograph, nearly all of which were taken by the senior author. Most are of good quality, but some photos are slightly dark (e.g., #28, 31, 36) and hide the color patterns of the specimens, while others could have been cropped and enlarged to show the species at a large scale (e.g., #55, 56, 58). The racerunner in photo #94 is nearly invisible. Unfortunately, a fair number of the photographs fail to clearly show the key features necessary for identifying each species, particularly by someone with no prior experience with a given species and no access to other field guides. In my mind, this is potentially the Achilles heal of an otherwise excellent book aimed at beginners. The hognose snake depicted in photo #80 exhibits a spectacular pattern that I have not personally seen in the wild. The color photographs are supplemented by simple, but effective, line drawings that illustrate key features of certain groups or species (e.g., vocal sac types of anurans, sexual dimorphism in turtle tails, skink head scales, belly and body scales in snakes). The book lacks dichotomous identification keys, which were likely omitted because they tend to be difficult for beginners to understand.

In summary, I believe this book is a valuable contribution to the herpetology of the Delmarva Peninsula and well worth the price. I hope that it meets its goal of educating more people about the fascinating array of amphibians and reptiles that inhabit this region. It should prove to be most useful to beginners, but contains information that will also be of interest to more advanced students. I have some concerns that the photographs of several species are inadequate to facilitate easy and accurate identifications by beginners. Mitchell (2003) noted that Roger Conant had intended to write a book on the Delmarva herpetofauna but was unable to finish it prior to his death. It will be interesting to see how this book, if completed by Mitchell as intended, compares with the field guide reviewed herein.

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Reports

1. Minutes of the November 2003 Council Meeting of the Virginia Natural History Society

The meeting was held on November 22, 2003 at Gilmer Hall, Hampden-Sydney College, Hampden-Sydney, Virginia. Council members in attendance were Barbara Abraham, Mike Donahue, Richard Hoffman, Michael Kosztarab, Anne Lund, Tom McAvoy, Dick Neves, Steve Roble, and Judy Winston. Barbara Abraham, Society president, presided. The minutes of the December 14, 2002 Council meeting had been approved earlier.

The secretary/treasurer reported a membership of 163 (paid for 2003), with a balance on hand, as of October 31, 2003, of $6,063.39. A gift from Dr. Bruce Parker, Virginia Tech, had helped our treasury considerably. Included in the total figure is $1,365.00 being set aside for BioBlitz 2004. Membership lists were circulated for council members to gather information and to correct any errors.

The editors reported that *Banisteria* #22 will be 60-70 pages and would go to press soon. Editor Steve Roble expressed thanks to Associate Editor Tom Wieboldt for getting the Breil paper on Piedmont mosses ready for the most recent issue (#21). It was noted that the spring issue for 2004 will soon be full, and the editors are aware of other manuscripts in revision or preparation for the fall 2004 journal. Roble expressed concern about getting a greater variety of papers into the journal, such as a paper on birds, for example, and more book reviews. It was also approved that articles for *Banisteria* should be submitted with abstracts and key words.

Old Business included a discussion of BioBlitz 2003. Ninety volunteers took part and 985 species, at least, were recorded. There was a discussion of how and when these results would and should be reported. Art Evans has volunteered to lead BioBlitz 2005 along the Potomac River (Maryland and Virginia shorelines), but there is no leader yet for BioBlitz 2004.

Also under Old Business, there was a discussion of membership. It was decided that we would send letters inviting those who had received *Banisteria* #21, and had not yet renewed for 2003, to renew their memberships. By a unanimous vote, membership rates were raised for institution, family, and regular members from $30, $20, and $15 to $40, $25, and $20, respectively. All other categories remain the same. This change will be reflected in the new brochure mailed with the renewal notices in *Banisteria* #22.

A motion was made by Dick Neves, seconded by Richard Hoffman, that page charges for nonmembers be raised to $15 per page. The motion carried.

Under New Business, advertising of *Banisteria* #21 among botanical organizations was discussed. Steve Roble presented a possible flier to be used for such a marketing effort. He agreed to provide a mailing list of organizations, compiled with the assistance of Tom Wieboldt, to Anne Lund.

Candidates for Vice President/President Elect and Councilor for the fall 2004 election were discussed. Several names were suggested as possible candidates for Vice President/President Elect. It was agreed that Paul Bedell will serve as councilor for five years in order to stagger the terms of the current councilors as required by the society's bylaws. A councilor needs to be chosen to serve for four years beginning in 2005, and several names were suggested.

Barbara Abraham announced a conference of interest to some members at Franklin and Marshall College in Lancaster, PA on the weekend of March 27–28, 2004.

Finally, it was agreed that it is not practical for the Society to change to another affiliate for its annual meeting other than VAS at this time.

Respectfully submitted,
Anne Lund, Secretary/Treasurer

2. Secretary/Treasurer's Report

We have 119 members, of which 18 are institutions or libraries. These are both new and renewed memberships for 2004. At the end of 2003, we had 166 members. Another reminder notice will be sent in June to delinquent members to encourage them to renew their memberships for 2004. As always, we encourage our active members to recruit members for the Society. A membership form is included with this mailing. Pass it on to a friend or colleague interested in the natural history of our state.

Our treasury presently holds $5,206.97 (as of June 1, 2004). Funds held in our society's treasury for BioBlitz 2004 were sent to the organizers of that event in the early spring. The society continues to operate in

the black. Donations would be welcomed, as publication of *Banisteria* continues to be our largest expenditure.

We continue to be grateful to Hampden-Sydney College for support with the paperwork concerning our treasury and membership records. Beckie Smith, secretary of Gilmer Hall, Hampden-Sydney College, does a great job of keeping up our membership records; she prepared all address labels for mailings. We thank the College for supplying their support to the Society.

Please submit all enquiries about membership in the Society or about past issues of *Banisteria* to: Dr. Anne Lund, Virginia Natural History Society, Box 62, Hampden-Sydney, Virginia 23943, or via email (alund@hsc.edu).

Respectfully submitted,
Anne Lund, Secretary/Treasurer

3. Editors' Report

The current issue of *Banisteria* (23) contains a mixture of floral, invertebrate, and vertebrate articles that illustrate the diversity of topics characteristic of this journal. We have several papers slated for Number 24 if they are returned following revision, thus we are in the rare position of having little concern for production of the next issue. That does not mean, however, that we are not seeking papers or smaller contributions. Please think about *Banisteria* for those unpublished theses and reports that include valuable natural history information.

This issue of *Banisteria* was printed by a press other than the one that we have been using in our efforts to save costs. If you have any questions about quality or other production issues, please contact the editors.

Note that the Instructions for Authors can be viewed on the VNHS website (http://fwie.fw.vt.edu/vnhs).

Respectfully submitted,
Joe Mitchell and Steve Roble, Co-editors

4. 2004 Virginia BioBlitz

The 3rd Annual Virginia Bioblitz was held on June 12-13, 2004 at Virginia Commonwealth University's Rice Center for Environmental Life Sciences in Charles City County. Chris Ludwig, Chief Biologist for the Department of Conservation and Recreation's Division of Natural Heritage served as the overall BioBlitz coordinator and Anne Wright of Virginia Commonwealth University handled logistical matters. Over 70 field biologists from around the state (plus several from South Carolina, Maryland, and Louisiana) participated in the 30-hour survey at the Rice Center, a recently acquired field station for VCU. With its 342 acres of diverse vegetation around Lake Charles and along the James River, the site was well suited for the event. The final tally was 873 species, including numerous species not previously recorded from Charles City County. A more detailed report will appear in a future issue of *Banisteria*.

5. Eleventh Annual Meeting of the Virginia Natural History Society

The 11th Annual Joint Meeting of the Virginia Natural History Society and the Natural History and Biodiversity Section of the Virginia Academy of Science was held on May 27, 2004 at Virginia Commonwealth University in Richmond. A complete list of papers presented at the session will be included in the next issue of *Banisteria*.

The Virginia Natural History Society
Application for Membership

Name ________________________________
Address______________________________
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Zip Code ____________________________
Phone _______________________________
Area of Interest _____________________
Email _______________________________

ANNUAL DUES AND SUBSCRIPTIONS
TO BANISTERIA
(all memberships and subscriptions
are by calendar year)

☐ $500.00 Life (not annual)
☐ $300.00 Benefactor
☐ $100.00 Patron
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☐ $40.00 Institutional
☐ $25.00 Family
☐ $20.00 Regular
☐ $5.00 Student (see below)

☐ I have added a contribution of $_________
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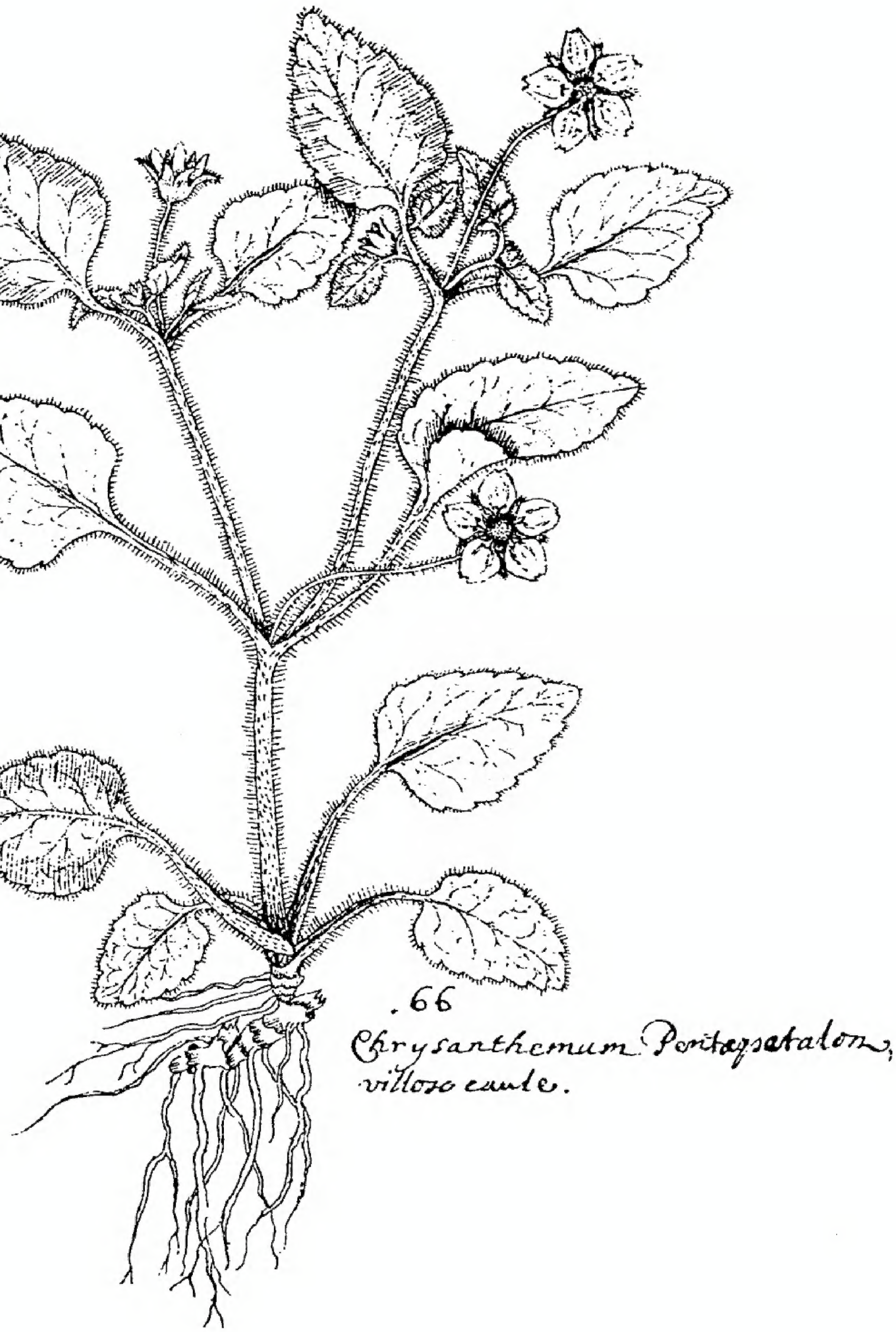
The special student rate is applicable only when accompanied by the following certification signed by a faculty advisor.

Institution ___________________________
Advisor _____________________________
Date________________________________



Chrysogonum virginianum Linnaeus

Original drawing by John Banister. Figure 83 in folio in Hans Sloane's MS 4002 in the British Museum. Photocopy courtesy of Joseph and Nesta Ewan.